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TABLE OF CONTENTS.

Engineering News of the Week.....97, 106, 117

Technical Articles:

Some of the Plans for Rapid Transit at New York..... 98
Estimating Overhaul in Earthwork (*illustrated*)..... 98
The substructure of the Cairo Bridge..... 99
Cannon for the New Navy..... 99
Designs for the Fort St. Union Station at Detroit, Mich. (*illustrated, with inset*)..... 99
Concrete Breakwaters (*illustrated*)..... 101
Legal Decisions of Interest to Engineers..... 103
The Fiske Electrical Range Finder (*illustrated*)..... 103
The Vogel System of Cable Railways (*illustrated*)..... 104
Operating Expenses and Receipts of the Chicago City Railway 105
The Relative Strength of High Explosives..... 105
The Zone Railway Passenger Fare System for Large Cities.... 106
A Large Special Casting (*illustrated*)..... 106
Railway Collisions in England..... 106
Coupling M. C. B. Couplers with Link and Pin Draw-heads (*illustrated*)..... 112
Efficiency of Chimneys..... 112
Regulations Concerning the Pollution of Streams in New Jersey..... 113
Hours of Labor of Railway Employees in England..... 113
Centrifugal Pumps (*illustrated*)..... 114
The Ten-Block System of Numbering Country Houses..... 115
Track for Electric Railway at Buda-Pest (*illustrated*)..... 115
Creoso e as a Preservative of Timber..... 115
Coffer Dam and Concrete Mixer at Mare Island Dry Dock, California..... 116
Cement-lined Wrought Iron Pipe vs. Cast-iron..... 116

Personals, New Publications, Society Proceedings..... 107

Editorial Notes..... 108

Steam Ejectors—Iron Production in United States—Rail Manufacturers of the United States.

Editorials:

The Problem of Flying..... 108
More New England Notions about Car Couplers..... 109

Correspondence..... 110

Compound Locomotive Tests—The "Soo" Water Power Canal—The Designers of the Phœnixville Testing Machine—Slide Rules and the Thacher Calculating Instrument—Sugar in Mortar—Wind Pressure Formulas—Formulas for Panel Loads—Random Notes from the Pacific Coast—Notes and Queries.

Construction News.....117-120

Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE NEW CROTON DAM AT CORNELL'S, approved by the Aqueduct Commission at its last meeting, and briefly noted last week, will be located about 3 miles below the old Croton dam, and about 1¼ miles above the proposed Quaker Bridge dam. The estimated cost is about $5,000,000. The adoption of this new site was practically the work of Mr. GILROY, the Commissioner of Public Works, and the only reasons advanced were that it would give more storage capacity and 21 sq. miles of additional drainage area, as compared with the dam No. 2, just below the old Croton Dam, lately recommended by the Chief Engineer. In referring to the Cornell site in his late report Mr. FTELEY says the width of the valley at high water mark is 1,736 ft.; the watershed is only 1½ sq. miles less than at Quaker Bridge, and that it is favorably situated for a partial earth dam with a side spillway. According to the sketch of this dam and its competing sites in our issue of Nov. 29, 1890, the Cornell site would call for a dam about 226 ft. high from bed rock to crest.

THE NEW GRAND CENTRAL STATION at Chicago, Ill., has a frontage of 680 ft. on Fifth Ave. and 223 ft. on Harrison St. The train shed has a single arch span of 50½ ft. radius, spreading out at the sides to make a total width of 146 ft. over the platforms, which are 19 ft. wide and 10 ins. high above the rail. The spaces between them are 23 ft. wide, accommodating three sets of tracks. It is lighted by 60 groups of incandescent lamps, 90 lamps of 32 c. p. at each end, and 7 powerful arc lights high up in the roof. The main waiting room is 71 × 267 ft. and 25 ft. high; ladies' parlor, 32 × 40 ft.; dining room, 53 × 73 ft. The tower is of Connecticut brownstone; it is 27 ft. square and 236 ft. high. The clock face is 13½ ft. diameter. There are 3 engines aggregating 550 HP. driving the electric light plant, which has a total capacity of 127,000 c. p. Compressed air is used to operate the switches, block signals, drawbridge and all crossing gates within 4 miles of the station. It is in its general effect one of the handsomest and most luxurious stations on the continent, although in size it is not specially remarkable.

THE WAGNER PALACE CAR CO. has won a temporary victory over the Pullman Palace Car Co. in a decision rendered on Jan. 20 by Judges GRESHAM and BLODGETT on a motion to restrain the Lake Shore & Michigan Southern and the Michigan Central railways from infringing the patent of GEORGE M. PULLMAN for solid vestibule connection for cars. Judge COLT, of Massachusetts, held that the patent granted to HENRY H. SESSIONS on Nov. 15, 1887, involved the same improvement, in a recent case, and the Chicago judges held that the decree declaring SESSIONS the first inventor remains in force until the matter comes to a final and later hearing.

THE HOUSATONIC DAM, near Birmingham, Conn., was seriously weakened as a result of the storm of last week. The east gatehouse is gone and with it over 100 ft. of the crest of the dam. This dam is curved, with a versed sine of 50 ft., and is 636 ft. long and 40 ft. high from the bed rock. It is built of stone laid in cement, with an earth back slope and timber overfall platform. It was built in 1864-70. The width of the dam at the base or river bottom is 25 ft., the height from surface of apron to crest is 22 ft., and the width of coping 8 ft. The face has a batter of about 2 ins. to 1 ft. The timber apron, filled in with concrete and placed on stone extending to the rock, projects 24 ft. out from the front toe. In 1869, while under construction, a heavy freshet undermined and carried away 160 ft. of the partially finished work, and scoured out a cavity 20 ft. deep in the river bed below. This cavity was filled in with loose rock and the work finished. The total cost of the dam was $264,000. It supplies power for 40 factories.

AMERICAN ARMOR PLATE, the first made at Bethlehem Iron Works, was successfully tested at Annapolis last week. The test plate was 11½ ins. thick and withstood three shots from the 35 caliber 6-in. gun, used in the test of last September. Haltzer armor-piercing projectiles were used, with an initial velocity of 2,100 ft. per second, and a striking energy of 3,100 foot tons. The plate stood the test better than the all-steel Creusot plate tested in September.

BIDS FOR A HYDRAULIC GUN LIFT were opened in New York last week. This lift is intended for use with the 12-in. high-power gun to be erected at Sandy Hook, and it is said to be the first hydraulic lift of this dimension ever proposed. The work was let to the Continental Iron Works, of New York, for $93,750. The bids ranged to $148,650. The mechanism is very complicated, and the plans were prepared on War Department specifications.

BRICK STREET PAVEMENTS were discussed at some length at the Indianapolis meeting of the Brick-Makers' Association last week. The following notes may be made: Some of the members present declared that a well laid brick pavement would last 30 years, and that the poorest brick pavement was better than wood. The standard strength of a good paving brick was put at the ability to resist a pressure of 6,000 lbs. per sq. in. The only brick pavement in Chicago is on Canal St., in front of the freight depot of the Chicago, Burlington & Quincy R. R.; it is 60 ft. wide, and was laid last March; it is subjected to very heavy service, and "now looks as well as when first put down."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision Jan. 26 on the Union Pacific Ry., at Florence, Kan. The trains were a passenger train and a double-header special carrying about 400 soldiers from Pine Ridge; the latter consisted of 7 passenger cars and 24 freight cars loaded with horses, artillery and ammunition. There were 2 men killed and about 14 seriously injured; the 3 engines and several cars were wrecked, and a number of cavalry horses killed. A collision on the New York Central & Hudson River R. R. near Peekskill, N.Y., was caused by the snowstorm on Jan. 25. A southbound freight train had stopped, and the signal was set against the Albany express, but the snow had obscured the signal, and the express ran into the freight, wrecking the express engine and smashing several cars.

BRIDGE ACCIDENTS are reported as follows: On Jan. 20 the greater part of a bridge carrying the East Tennessee, Virginia & Georgia R. R. over the Ocmulgee River was destroyed by fire. A large iron bridge on the Central New England & Western R. R., near Poughkeepsie, N. Y., and 2 or 3 bridges on the New York & Massachusetts R. R., near Pine Plains, N. Y., have been carried away by the recent floods. The Hamilton St. bridge at Poughkeepsie has also been carried away.

THE PROPOSED SHIP CANAL, connecting Chicago, Duluth and Buffalo, has been reported upon by Col. O. M. POE, Corps of Engineers. He has made a preliminary examination only, in accordance with the river and harbor act of 1880. The estimated cost of connecting the shallow waters by a 20-ft. channel is $2,379,085; and for a 20 and 21-ft. channel, $3,339,567; Col. POE recommends 21 ft., and he assumes 300 ft. as the minimum width of channel everywhere except at St. Mary's Falls Canal. The commerce passing between Lakes Huron and Erie exceed 22,000,000 tons, annually.

THE BROOKLYN BRIDGE TRUSTEES are pushing the plans lately adopted, and a bill is now drafted providing for the issue of $1,500,000 bonds for the improvement in the carrying capacity of the bridge, and $1,000,000 bonds for the approaches. As New York objects to paying for local improvement in Brooklyn, the bill provides that New York is to pay one-third only on the latter account, but one-half of the cost of work on the bridge proper.

THE STATE CAPITOL at Albany is to have another appropriation of $2,600,000 "to repair and complete it." The original structure was to cost $4,000,000, but $20,000,000 has been expended upon it. The New York *Tribune* remarks with justice, that some people are getting very "tired" of these annual "final" appropriations, and the blunders in design and construction that make them necessary.

THE CUNARD STEAMSHIP CO. has contracted for two fast steamers of 12,000 tons each to cost $2,000,000 apiece. The ships are to be built on the Clyde and the promised speed is 22 knots per hour, or 5 days and 8 hours between Queenstown and New York.

THE ADIRONDACK WILDERNESS, according to the last annual report of the State Commission, contains 3,588,803 acres, of which 2,247,039 is non-resident lands, 696,938 resident, and 644,826 State lands. The total assessor's valuation is: Improved lands, $1,000,065; unimproved, $4,061,006. In the area 341,207 acres are of private reserves, 104,143 acres are improved. The water area is 67,686 acres. The boundaries of the proposed land include 2,307,760 acres, of which 1,495,358 acres are non-resident, 300,173 acres resident, and 512,229 acres State lands. They are classified: Improved, 64,717 acres; wild meadow, 495; water, 57,104; waste, 18,526; burned, 13,430; denuded, 50,050; lumbered, 827,955; forest, 1,275,483. The lands of the private preserves are all included within the park boundaries. To erect the park proposed by the Commission it is necessary for the State to acquire 1,332,503 acres.

STREET CLEANING in Rome, N. Y., is said to be well done on a plan started 25 years ago. The city ordinances make every property owner or tenant responsible for the condition of the half-street in front of his residence or place of business. If the work is not done well, the city performs it and taxes the owner with the cost. In every lease there is a provision making the tenant responsible for the condition of the street. The cleaning is performed once a week, on a certain day, and the city at the same time removes the rubbish gathered up. We tell the story as it was told to us.

THE ST. SEBASTIAN SUGAR CO., says the *Florida Times-Union*, has purchased 125,000 acres of land on the St. Sebastian River in that State for sugar planting. About 75,000 acres of this land is said to have an underlying stratum of muck 10 to 30 ft. deep. The company proposes to cut a drainage canal to the Indian River, to cost about $50,000. The men at the head of this enterprise are Messrs. C. G. BUTT, M. R. MARKS and W. L. PALMER, of Orlando, Fla.

THE MISSISSIPPI RIVER LEVEE BILL, appropriating $10,000,000 for repairs and new construction, was favorably reported upon by the House Committee on levees. The territory covered extends from Cairo to the Passes, and the money would be expended under the Mississippi River Commission. The report approves of the methods pursued by the Commission.

Some of the Plans for Rapid Transit in New York.

At the meeting of Jan. 22 of the Rapid Transit Commission for New York the following were among some of the many plans presented for the solution of the present problem:

The New York Underground Railway Co. was represented by Mr. OLIVER W. BARNES. This company is the successor of the New York City Central Underground Railway Co., incorporated in 1868. Generally speaking, the Southern terminus would be at the City Hall, and it would nearly follow the line of Mulberry St., and through private property, to Madison Square, and thence out Madison Avenue to 134th St.

The New York City Railway Co. was represented by its engineer, Mr. THOMAS C. CLARKE. This company was organized in 1888. Below Central Park two tracks were believed to be sufficient, but above that point four tracks were proposed. To prevent overcrowding Mr. CLARKE intended to entirely separate the incoming and outgoing passengers by providing stations 125 ft. wide for a 4-track road. He proposed to run the two express tracks in a single central tunnel and put the local tracks in two smaller tunnels on each side in a total width of 50 ft. Express stations would be one mile apart. He would construct his tunnels as near the surface as existing substructions would permit. He would use electricity as a motive power, and said that a speed of 25 miles per hour would always be available.

Col. ROWLAND HAZARD then showed a model of an underground Broadway road for four tracks, with disposal of pipes, wires, etc. Mr. R. W. GIBSON submitted another Broadway plan, and Mr. E. M. BOYNTON advocated the adoption of his bicycle plan on the existing elevated system, and claimed that he could thus run trains from the Battery to Harlem in less than 10 minutes. Mr. T. G. GRIBBLE proposed to unite a surface railway and an underground railway under one system, operated from one power station. They may be worked by cable or electricity, with preference given for the latter. The surface road would have a speed of 6 to 8 miles and the underground express a speed of 30 miles per hour. Mr. W. E. MAGUIRE suggested a two-story elevated structure, and Mr. J. W. RENO advocated a two-story tunnel.

Estimating Overhaul in Earthwork by Means of the Profile of Quantities.

BY S. B. FISHER, CHIEF ENGINEER OF THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY., MINN.

No facile, practical and accurate method of calculating the overhaul of earthwork is as yet in common use. The problem itself, consisting of finding the relations between the centers of gravity of known volumes in known positions may be, from the mathematician's point of view, a comparatively simple one; but such a lack of readiness to solve it has the engineer shown that many a contract has been executed with the privilege of wasting and borrowing at the end of the haul. This practice results at times in waste of energy by the contractor, and still oftener in the waste of money to the other party to the contract. By the system of wasting and borrowing, material is paid for at the full price of excavation beyond the haul, but with the judicious use of overhau', in many cases the material may be hauled half a mile before its price is doubled. When, from the increase of the traffic of a railroad, for example, it becomes necessary to grade for a second track, and in so doing to remove material wasted on the margin of a cut into an adjoining borrow pit along the neighboring fill, where it ought to have been deposited in the first place, it neither increases the respect of the later engineers for their predecessors, nor is it a credit to the profession.

Overhaul as commonly worked out is done in an approximate manner with the ordinary profile and the volumes in excavation and embankment. It takes longer to work it out with the "Profile of Quantities," of which a short example is engraved, but it is done completely and accurately.

The method of the profile of quantities was originated by BRÜCKNER, a Bavarian engineer. It was presented by CUHLMAN in his "Graphical Statics" in 1868, and translated from that by F. REINEKER, then (1871-3) Principal Assistant Engineer of the Pennsylvania Co., at Pittsburg, Pa., for the use of his department. This translation was procured there by the writer, and the method adapted to American practice in a great variety of railway work, and is here given with an example of work as actually executed.

The subject is presented, for convenience and clearness, in three steps:

1st. *The Compilation of the Data.* 2d. *The Plotting of the Profile.* 3d. *The Taking off of the Results.*

1. *The Compilation of the Data.*—The paper containg the data is ruled in five vertical columns, as in the following sample table:

SAMPLE TABLE OF COMPUTATIONS FOR CONSTRUCTING "PROFILE OF QUANTITIES."

O. & S. W. R. R. Data for Profile of Quantities. Section 5, Oct. 1, 1889.

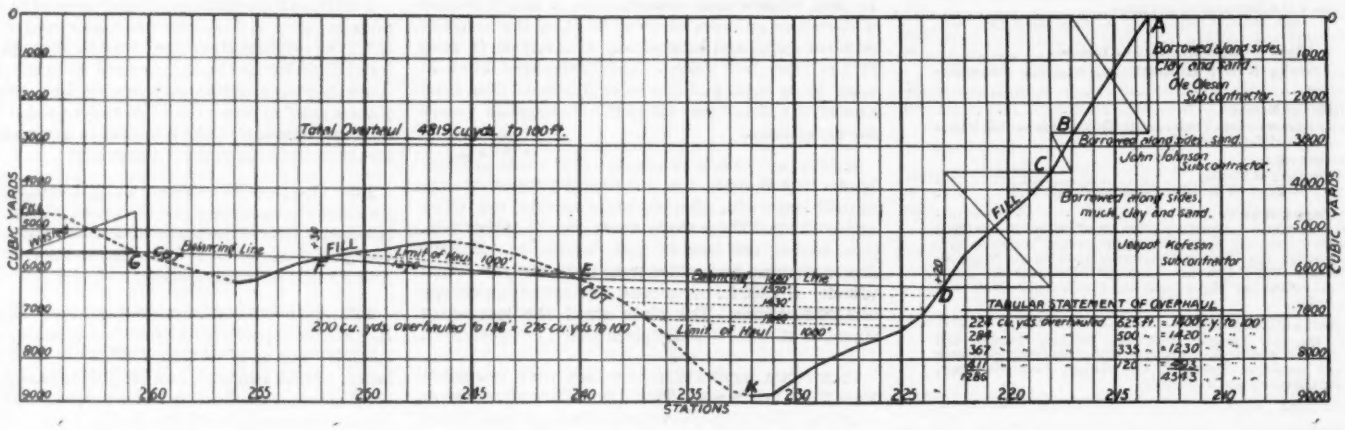
Sta.	Increments. +	Increments. −	Ordinates. +	Ordinates. −	Sta.	Increments. +	Increments. −	Ordinates. +	Ordinates. −
213+34	...	....	.....	.....	240	224	...	.....	6,155
214	....	370	.....	370	1	200	...	.....	5,955
5	....	843	.....	1,213	2	180	...	.....	5,770
6	....	779	.....	1,991	3	185	...	.....	5,585
7	....	724	.....	2,715	4	156	...	.....	5,429
8	....	902	.....	3,617	5	102	...	.....	5,327
9	....	570	.....	4,187	6	59	...	.....	5,268
220	....	391	.....	4,578	7	....	14	.....	5,272
1	....	457	.....	5,035	8	....	70	.....	5,342
2	....	535	.....	5,570	9	....	83	.....	5,425
3	....	678	.....	6,248	250	....	78	.....	5.503
4	....	725	.....	6,973	1	....	65	.....	5,568
5	....	344	.....	7,317	2	....	70	.....	5,638
6	....	193	.....	7,510	3	...	124	.....	5,762
7	....	156	.....	7.666	4	....	181	.....	5,943
8	....	244	.....	7,910	5	....	189	.....	6,132
9	....	221	.....	8,131	6	....	85	.....	6,217
230	....	356	.....	8,487	7	55	...	.....	6,052
1	....	317	.....	8 804	8	156	...	.....	5,896
2	....	83	.....	8,887	9	102	...	.....	5,794
3	161	....	.....	8,726	260	146	...	.....	5,658
4	328	....	.....	8,3 8	1	206	..	.....	5,452
5	464	....	.....	7,934	2	237	...	.....	5.215
6	493	....	.....	7,441	3	250	...	.....	4,965
7	411	...	.....	7 030	4	274	...	.....	4.691
8	867	....	.....	6.063	5	47	..	.....	4.644
9	284	....	.....	6,379	6	....	6	.....	4,650

The first column contains the station numbers. In practice the elemental volume is the total excavation or embankment in a full station, whether the station distance is 100 ft., 66 ft., or a number of metres. Plusses are not used, excepting at an occasional beginning or end of a subsection, although the system is flexible enough to apply to any regular or irregular subdivision of these elemental volumes.

In columns 2 and 3 are now entered the total *increments* or volumes of earthwork in excavation or embankment in successive stations. When excavation and embankment both occur within the limit of the same station the net amount only need be entered. If there is a special price for casting within the station another column may be introduced for it. Excavation is considered plus and embankment minus. The latter may be entered in red ink.

Columns 4 and 5 are now filled up by algebraic addition of columns 2 and 3. The ordinate at any point of the "Profile of Quantities" is equal to the algebraic sum of the volumes as far as to that point, and should be verified by use of this principle, at convenient points, as the summation proceeds.

2. *The Plotting of the Profile.*—The horizontal part of the plotting is the same as used in the ordinary profile, and it may be made on the same sheet of paper, but for the vertical part, instead of elevations being referred to a datum plane, at or below the lower edge of the profile paper, we have an initial line or axis of abscissas, located somewhere on the profile, from which the ordinates are measured above for plus and below for minus. Connecting the ends of these ordinates, we have a broken line, which in mathematical language may be called a curve, resembling somewhat an ordinary profile, but wholly different therefrom, composed of the elements between the successive stations.


Total Overhaul 4819 cu.yds. to 100 ft.
Borrowed along sides. Clay and Sand. Ole Olesen Sub Contractor.
Borrowed along side, sand. John Johnson Sub Contractor.
Borrowed along sides, much clay and sand. Teapot Kofeeson Subcontractor
Balancing Line
Limit of Haul 1000'
200 cu. yds. overhauled to 138 + 226 cu yds to 100'
TABULAR STATEMENT OF OVERHAUL
CUBIC YARDS
STATIONS

SAMPLE PROFILE OF QUANTITIES.

If the increment, by the use of which any ordinate is formed from the previous one, is positive, this element of the curve will incline upward, will indicate excavation and be shown by a dotted or blue line. If the increment is negative the element of the curve will incline downward, will indicate embankment and be shown in red or by a solid line. So that excavation on the profile of quantities is always shown by an ascending dotted or blue line, and embankment by a descending solid or red line.

We now consider the *balancing line.* Some points of this line are always fixed by the patent conditions of the work, and occasionally all points are so fixed, but very often some points on it are indeterminate at first, so that each section is very likely to be a little problem by itself. The functions of the balancing line will most clearly be seen by referring to the engraved sample profile. We have here the first point of it, *A*, the beginning of the section; *B*, the end of OLE OLSON'S job; *C*, the end of JOHN JOHNSON'S job; *D*, the end of TEAPOT KOFEESON'S job; *E*, at station 240, the dividing point between backward and forward hauls in the cut; *F*, station 252 + 30; *J*, junction point of forward and backward hauls in the fill; *G*, the point where waste commences in the second cut, and *H*, the end of the section.

The Taking Off of the Results.—From *A* to *D* there is no overhaul, but the nature of the material and any other items can be conveniently recorded there. The fill between *D* and *K*, is made from the cut between *K* and *E*. We first fix the position of the limit of haul, which here comes between station 226

and 230, and then draw the intervening lines of overhaul to each point of flexure of blue and red lines. We now read the elements of the cut between these lines of haul, from the profile m, or if we desire great accuracy, from the data prepared for plotting the profile n and tabulate them. Each of these elements multiplied by its respective distance overhauled will give equivalent quantities overhauled to one station; as for example, $224\ cy \times \frac{1680 + 1570}{2} - 1000 = 224 \times 6.25 = 1390$. The sum of these partial products will give the total overhaul for the cut. The tabulation should always be verified, by seeing that the sum of the elements of the blue or red curve, as the case is, is equal to the difference between the extreme ordinates.

If $E - K$ is rock or $D - K$ is a sink hole, the line $E\,D$ will be inclined, and should be prolonged to an intersection with the horizontal through K. This intersection then becomes a pole, through which the lines of haul are drawn. The method is so flexible it can be applied to anything which can be executed in earthwork, and in addition gives a record of what has been done. It is also used to make the preliminary distribution of material before the work is begun.

Cement Tests at the Cairo Bridge.

From a paper by Mr. E. H. CONNOR, in the *Transactions of the Association of Engineering Societies*, we make the following abstract of the cement tests made during the work on the substructure of the Cairo Bridge:

The records cover tests on a number of natural cement mortars and on different brands of Portland cement and a statement of the quantities of materials used in the masonry.

The evil effects of freezing were shown by a series of tests on 50 briquettes of Louisville cement mortar. These briquettes were allowed to set in the air under a damp cloth in the test room for 24 hours. Twenty-five were then placed in water until a part of them were broken at the end of 28 days, showing 75.8 lbs. tensile strength, others at the end of 3 months showing 130 lbs. strength, and the remainder at the end of 6 months showing 138.4 lbs. strength. The remaining 25 were removed from the test room, frozen during the following night, and then placed in water at a temperature of 70° Fahr. When thawed 11 were found to be broken, and 4 more broke on being removed from the pans the following night to refreeze. After a second freezing and thawing the remaining 10 broke.

The effect of salt on the strength of two brands of cement is shown in the accompanying table. The mortars were mixed in the proportion of 1 volume of cement to 2 volumes of sand. The tests were made in the manner recommended by the Am. Soc. C. E.:

Brand of Cement.	Fineness. ℔ passing No. 50 sieve.	Fineness. ℔ passing No. 100 sieve.	Tensile strength in lbs. per sq. in. for varying per cents of salt in water. 0 ℔ salt.	2 ℔ salt.	4 ℔ salt.	8 ℔ salt.	12 ℔ salt.
Portland:							
Alsen's.....	99.2	87.0	200.9	212.8	223.1	215.2	244.9
Louisville:							
Falls City Mills.	92.4	83.5	175.5	179.4	171.7	145.9	156.4

Each result is the mean obtained from 10 briquettes at the age of 6 months.

Ordinary sea water contains 2½% of salt and 3.4% of saline matter. It will be seen that the Portland cement briquettes were largely increased in strength by the salt, in close correspondence with the more extensive tests recorded in our issue of Dec. 20, 1890; but the Louisville cement above seems to have suffered from the salt, whereas Rosendale cement seemed to be benefited even more than Portland cement in the tests published Dec. 20.

An interesting set of tests was made on 20 briquettes composed of 1 volume of Louisville Black Diamond cement and 2 volumes of sand. When 10 of these briquettes had been allowed to set 24 hours between blotters immediately after being taken from the moulds, and then were placed in water, it was found that their average tensile strength after 28 days was 20.7 lbs. per sq. in. When the other 10 briquettes had been treated in the usual manner, and were tested at the end of 28 days, it was found that their tensile strength was only 7.4 lbs. per sq. in.

The effect of mixing limestone screenings and sand with the Portland cement was found to be as follows:

Proportion by volume. Cement.	Sand.	Dust.	Stone and dust mixed.	Strength in lbs. per sq. in. at end of 7 days.
1	0	0	0	536
1	0	1	0	404
1	0	2	0	274
1	0	0	1	412
1	0	0	2	347
1	1	1	0	218
1	1	0	1	180
1	2	0	0	147
1	2	0	⅔	135

Tests 1 to 7 are the mean results of 5 briquettes; 8 and 9 are the means of 10 briquettes. Stone signifies stone screenings passing a No. 6 sieve and held on a No. 20. Dust signifies stone screenings passing a No 20 sieve. Stone and dust mixed refers to every thing passing a No. 6 sieve.

The following table, showing the effect of fine grinding, is condensed from a much larger one in Mr. CONNOR's paper:

TENSILE STRENGTH IN POUNDS PER SQUARE INCH AT AGE OF SIX MONTHS.

		Louisville.	Portland.
Sifted cem., 10 vols. Screenings, 6 "	Cem., 1 Sand, 0	320	620
	Cem., 1 Sand, 1	283	478
	Cem., 1 Sand, 2	190	822
Sifted cem., 9 vols. Screenings, 1 "	Cem., 1 Sand, 0	335	621
	Cem., 1 Sand, 1	208	450
	Cem., 1 Sand, 2	192	290
Sifted cem., 8 vols. Screenings, 2 "	Cem., 1 Sand, 0	318	630
	Cem., 1 Sand, 1	290	436
	Cem., 1 Sand, 2	181	263
Sifted cem., 7 vols. Screenings, 3 "	Cem., 1 Sand, 0	305	692
	Cem., 1 Sand, 1	280	391
	Cem., 1 Sand, 2	173	249
Sifted cem., 6 vols. Screenings, 4 "	Cem., 1 Sand, 0	319	712
	Cem , 1 Sand, 1	249	352
	Cem., 1 Sand, 2	161	224

Sifted cement is such as will pass a No. 100 sieve, while screenings are the parts which will not do this. Each result is the mean of 30 briquettes.

Cannon for the New Navy.

The Chief of the Ordnance Bureau of the Navy Department has had published, for the use of the service, a table giving complete and accurate details of all the built-up steel rifled guns for the navy. This table is chiefly valuable to ordnance experts and officers of the ships on which the various guns are mounted, but there is much in it of general interest, as it exhibits in a very graphic manner the advance made by the Ordnance Bureau since the construction of guns of this character was first undertaken.

This improvement has been particularly noticeable in the 6 in. guns. The first of this caliber, officially known as "6-in. B. L. R., Mark I,' weighed 4.8 tons, with a total length of 15.8 ft., a total length of bore of 176 ins., and a length of rifling of 136.65 ins. This gun, with a service charge of 50 lbs. of powder, was capable of giving an initial velocity of 2,000 ft. per sec. to the 100-lb. projectile, giving it a striking energy at the muzzle of 2,773 ft.-tons.

The next improvement was the Mark II gun, in which the same results were obtained with from 45 to 48 lbs. of powder, as with 50 lbs. in the first gun. The weight of this gun was increased one-tenth of a ton. It was lengthened to 16.1 ft., with a bore 180.08 ins. long and 144.85 ins. of rifling.

The next gun was the Mark III, of 30-caliber length, in which, although the gun was lengthened, together with the bore and the rifling, the weight was reduced to the same as the first type, and the measured length, together with an improvement in rifling, enabled the same initial results to be obtained with the charge of powder still further reduced to from 44 to 47 lbs. This is the 30-caliber 6-in. gun carried by most of the new cruisers, and it is probably as nearly perfection as could be reached in a gun of 30-caliber length.

Since then, however, guns of 35 calibers, or a total length of 18.8 ft., and a corresponding increase in the length of bore and rifling have been made, giving with the same charge as the perfected 30-caliber gun an initial velocity of 2,080 ft. per sec. and an initial energy of 2,990 ft.-tons. It was one of these guns that gave such excellent results at the Annapolis armor tests in September last.

The 6 in. gun turned out in the future will be even better than this, being 40 calibers in length, or 21.3 ft. over all. This gun will, with the same service charge, give an initial velocity of 2,150 ft. per sec. and a muzzle energy of 3,204 ft.-tons. This improvement can best be appreciated when it is said that a shot from the 30-caliber guns could penetrate 10.27 ins. of steel at the muzzle, while one from the 35-caliber gun could penetrate 10.86 ins., and one from the 40-caliber 11.38 ins. Similar improvements can be traced in the 8 and 10-in. guns.

The most remarkable results are obtained with the 5-in. rapid fire gun, weighing 3.1 tons, with a total length of 17.4 ft. This gun, with a service charge of 28 to 30 lbs. of powder, will give to its 50-lb. projectile an initial velocity of 2,250 ft. per sec., a striking energy of 1,754 ft.-tons, and a penetration of 9 ins. of steel.

The largest guns at present contemplated by the bureau are the 13-in. guns for the new battle ships. They will weigh 60.5 tons, and have a total length of 40 ft. The projectile will weigh 1,100 lbs., and will be impelled by a charge of 550 lbs. of powder. The velocity will be 2,100 ft. per sec., and the enormous striking energy of 33,627 ft.-tons will be attained, giving a penetration of 26.66 ins. of solid steel. This gun will be capable, under favorable conditions, of piercing the heaviest armor afloat in any navy, and the explosion of one of its enormous shells below the water line would probably disable any ship in existence.

Designs for the Fort St. Union Station at Detroit, Mich.

(WITH INSET.)

The city of Detroit is now reached by the lines of eight railway companies. There are in the city three main passenger stations. The largest and best of these is that of the Michigan Central R. R., which is at present used also by the Detroit, Lansing & Northern and the Flint & Pere Marquette railways. The Grand Trunk lines and the Detroit branch of the Lake Shore & Michigan Southern use another station, and the Wabash uses the third. The Canadian Pacific extension from London, Ont., terminates at Windsor opposite Detroit, and eventually trains will be run into and out of Detroit, being transferred by boat across the river. The Fort St. Union Depot Co. was formed to build a new Union depot for the use of the Wabash, Canadian Pacific, Flint & Pere Marquette and Detroit, Lansing & Northern railways, with connecting tracks giving access to the station by the different railways interested.

Competitive designs from different architects were called for in the fall of 1889, and a very large number were presented. We show herewith the design finally adopted and which is now being erected, which was made by Jas. Stewart & Co., of St. Louis; and also show on our inset sheet a very handsome design for the same station, submitted by Mr. BRADFORD L. GILBERT, of New York City.

The site for the new station is at the corner of Fort and Third Sts., a few blocks north of the Michigan Central station, and somewhat further removed from the river than that building. The heavy expense for foundations necessary in the made ground near the river, was therefore avoided here. Fort St. is one of the principal residence streets of the city, and a large church with high spire on the corner opposite the site of the station made a building of considerable height necessary in order that it should not be dwarfed by the church. A train shed was not called for, it being considered better to put all the money available into the main structure and place shed roofs over the platforms, leaving the train shed to be built, perhaps, at some future day.

In the call for designs by the Depot Co., the cost of the building was set at $125,000 to $175,000, and it was desired to have the main building as handsome as possible and finished throughout in the best and most convenient manner. The station was to have eight tracks, as shown in Mr. GILBERT's plans; but in the adopted design only six tracks are provided. The amount to be expended on the building was also changed from that originally proposed, and the

cost of carrying out the adopted design is set at $225,000.

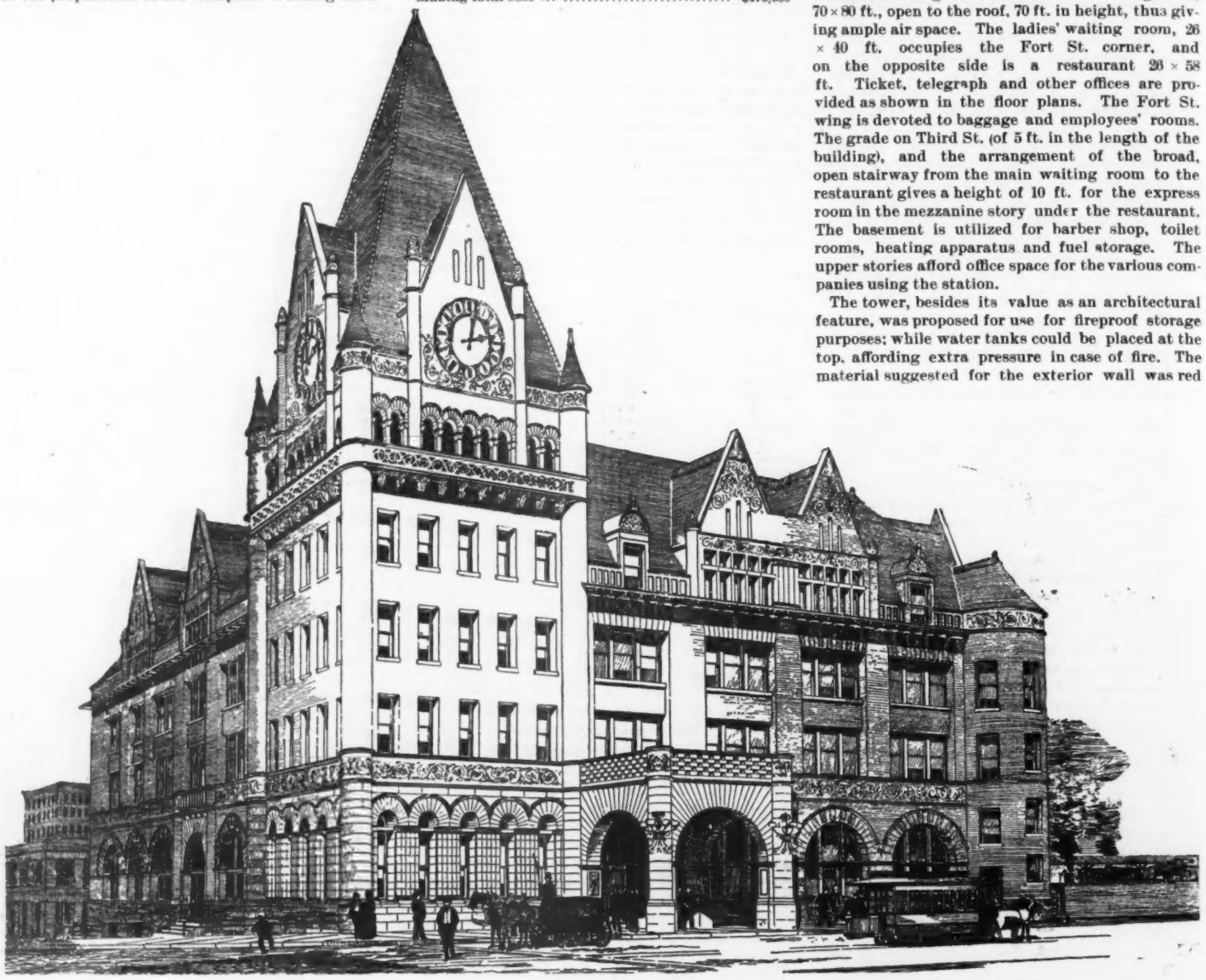
Mr. GILBERT's designs were accompanied by an estimate of cost based on other work of similar character carried out by him, and a statement that he would agree to contract the work with first class men and have the same completed within the cost named; or, if unable to fulfill this agreement, he would make no charge for professional services or for the preparation of the complete working drawings and specifications, upon which bids were to be asked. The following was the estimate:

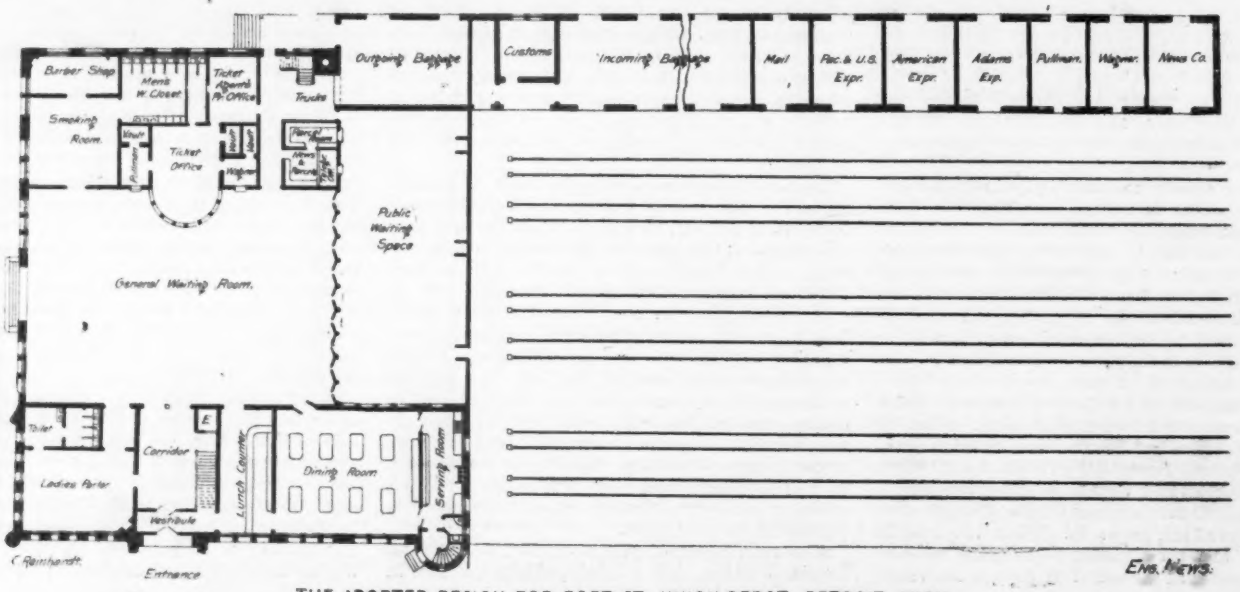
Main building, 140 ft × 70 ft	$75,000
Tower (above main building)	6,000
Fort St. wing	40,000
Covered pla form as shown	12,000
Concrete platforms	12,000
Steam plant and ventilation	12,000
Plumbing	4,000
Marble floor of rotunda	5,000
Electrical plant and elevator	10,000
Making total cost	$176,000

As an evidence of the accuracy of this estimate it may be noted that the Depot Company's engineer prepared separate estimates of the cost of carrying out Mr. GILBERT's plans, and, without knowledge of Mr. GILBERT's estimates or any interview with him, reported the probable cost as "$174,000, or very nearly that amount."

The principal features of the designs by Mr. GILBERT are as follows: The main building, 140×170 ft., contains on the ground floor the main waiting room, 70×80 ft., open to the roof, 70 ft. in height, thus giving ample air space. The ladies' waiting room, 26 × 40 ft. occupies the Fort St. corner, and on the opposite side is a restaurant 26 × 58 ft. Ticket, telegraph and other offices are provided as shown in the floor plans. The Fort St. wing is devoted to baggage and employees' rooms. The grade on Third St. (of 5 ft. in the length of the building), and the arrangement of the broad, open stairway from the main waiting room to the restaurant gives a height of 10 ft. for the express room in the mezzanine story under the restaurant. The basement is utilized for barber shop, toilet rooms, heating apparatus and fuel storage. The upper stories afford office space for the various companies using the station.

The tower, besides its value as an architectural feature, was proposed for use for fireproof storage purposes; while water tanks could be placed at the top, affording extra pressure in case of fire. The material suggested for the exterior wall was red





THE ADOPTED DESIGN FOR FORT ST. UNION DEPOT, DETROIT, MICH.
Jas. Stewart & Co., Architects.

brick, with dark red Lake Superior sandstone for trimmings.

In the adopted plans the main building has about the same frontage (138 ft.) on Third St., and about 125 ft. on Fort St., or 55 ft. more than in Mr. GILBERT's design. The wing, however, is placed on the other side of the tracks, and is much reduced in size. The tower is to rise to a height of about 170 ft., and is very much larger than in the other design shown. The material is to be red brick and stone. We are indebted to the *Railway Review* for our illustrations of the adopted design.

Concrete Breakwaters.

In 1822, Congress appropriated $22,700 for a survey of Delaware Bay near Cape Henlopen, for the purpose of determining a site for a harbor of shelter. Since that time, work has been done at irregular intervals until at present there is a breakwater 2,558 ft. long and an ice breaker of 1,359 ft. The increase in the dimensions and draft of vessels since the work was first designed, together with the shoaling that has taken place behind the breakwater, renders the present harbor under these changed conditions, inadequate for the requirements of commerce. Hence it was decided to close the gap of 1,350 ft. between the breakwater and ice breaker, giving additional anchorage area and making the harbor of great value to coasting vessels.

The project proposes a random stone substructure with a sea slope of 1 vertical to 2 horizontal and a harbor slope of 1 to 1¼. The top of the structure is to be 62 ft. wide and 15 ft. below mean low water. The concrete superstructure is to be 27 ft. high and 27 ft. wide, and its top will be 7½ ft. above mean low water. From its base to a height of 2 ft. above high water, it is to be built of concrete blocks; the remaining 5½ ft. to consist of a concrete monolith.

This work is very interesting from an engineering point of view and when completed will rank among the leading examples of its kind in the world. Mr. L. Y. SCHERMERHORN, Assistant Engineer in the U. S. A. Engineering Corps, has made an exhaustive report, which we abstract below, on all the principal breakwaters consisting of a concrete superstructure on a random stone substructure.

The following table gives the principal dimensions of these breakwaters:

Locality.	Superstructure. Depth below M. L. W.	Superstructure. Height above M. L. W.	Superstructure. Total height.	Superstructure. Width.	Range of tides.	Height above H. W.	Depth of water over site.
Colombo, Ceylon...	*20	12	32	34	2.0	10	18-40
Madras, India.....	22	8	30	24	3.3	4.7	24-45
Mormugao, India..	†18	‡20	38	30	6.0	14	29- 8
Manora, India.....	15	9	24	24	8.7	0.3	18-30
Kustendjie, Turk'y§	†16	12	28	12-18	....	12	12-20
Odessa, Russia§...	22	10	32	22-28	....	10	20-70
Fiume, Austria‖ ...	22¾	.....	24	23½	1.5	1.5	20-70
Ymuiden, Holland.	†25	18	43	28-38	5.5	12.5	10-30

* Rubble and 10-ton bags of concrete extend about 5 ft. above the base. † Sea-face and slope protected with large concrete blocks. ‡ Includes a parapet 7 ft. high and 15 ft. thick. § Upon the west shore of the Black Sea ‖ Upon the Gulf of Quarnero, Adriatic Sea.

Of the foregoing breakwaters Colombo, Madras, Mormugao, Manora, and Ymuiden are exposed to ocean waves, Kustendjie and Odessa to the waves of the Black Sea, and Fiume to the waves of the Gulf of Quarnero, on the Adriatic Sea.

In the first four and last works in the above table, the foundations of the concrete superstructure are placed from 15 to 25 ft. below mean low water. This might have been adopted for two reasons, viz.: (1) Economy of construction; (2) stability of the work.

In the case of Ymuiden Breakwater, where the rubble base was only 3¼ ft. in thickness, it seems highly probable, from the known absence of stone within reasonable distance from the site of the work, that the depth of 25 ft. was chosen from grounds of economy. Excluding Ymuiden, for the remaining four works the depth of the concrete foundation varies from 15 ft. at Manora to 22 ft. at Madras.

The earlier breakwaters, even when provided with a superstructure or parapet, presented to the sea a face of random stone, with slopes of from 1.5 to 1.7 between high water and about 12 ft. below mean low water. The effect of these long flat slopes leading up to the parapet naturally reduced the force of the waves and materially lessened the back draft of the seas and their effect upon the stone forming the sea slope below the surface of low water.

From the experience gained in the older types of breakwaters it was inferred that the waves had no influence upon large rubble at a depth of 12 ft. below mean low water; but that which was true of the older types, with flat slopes extending well above the surface of the water, ceased to be true when the wave was met by a vertical wall founded at a depth of 12 ft. or more below mean low water. The recoil of a wave from a vertical face is so much more severe than the recoil from a long flat slope, that it seems only natural to expect that the disturbance of the rubble base in the former case would be carried to a much greater depth than in the latter. Consequently the limiting depth at which rubble was found to be undisturbed in the older types of breakwaters was not a safe criterion when applied to breakwaters surmounted with a vertical superstructure extending well below the surface of mean low water.

This radical difference between the action of a vertical wall and flat slopes of random stone has resulted in material changes of opinion as to the limiting depth of wave disturbance, and where a depth of 12 ft. was formerly considered sufficient to place rubble stone beyond the action of waves, depths of 18, and even 22, ft. are now advocated and used.

At Alderney, the rubble base was originally placed at 12 ft. below mean low water, but before a condition of stability was attained the top of the rubble mound at the base of the superstructure had been reduced to a depth of between 15 and 18 ft., and even at this depth it was necessary to maintain the top of the rubble with added material to replace that which was swept away. There is most manifest economy in either placing the rubble so low at the first as to secure its stability, or else protecting it with stone too large to be removed. Otherwise the stability of the whole work is endangered, or else a large annual expense must be incurred to supply the waste and thereby insure the work.

At Tynemouth, where the superstructure is founded at a depth of 20 ft. below mean low water, it has been necessary to protect the top of the rubble mound on the sea face with a double row of large concrete blocks.

At Colombo the base of the superstructure at 2,000 ft. from the shore, and in water 30 ft. deep, is placed 16 ft. below mean low water, but the sea face of the work is protected by large rubble stone raised to a height of 5 ft. above the base, and such stone further protected with a close layer of 10 ton bags of concrete. At 3,000 ft. from the shore, and in water 40 ft. deep, the superstructure is carried to a depth of 20 ft. below mean low water, and then protected by large rubble and concrete bags.

At Madras the base of the superstructure, founded 22 ft. below mean low water, seems to have been sufficiently deep to protect the top of the rubble base from the effect of wave recoil. Nevertheless, in the amended project for the extension of the Madras breakwater a wave breaker is provided along the sea face of the superstructure, consisting of large random blocks of concrete piled against the sea face and extending to the plane of high water.

At Mormugao the base of the superstructure, founded 18 ft. below mean low water, has been protected on its sea face by a wave breaker consisting of 20-ton concrete blocks extending above the plane of high water.

At Manora the superstructure, founded at 15 ft. below mean low water, has not suffered from any reduction of the rubble base. This is probably due to the reduced exposure of the locality, joined with the fact that the superstructure is so low, practically the plane of mean high water, that the seas easily pass over the work, and consequently greatly reduce the back draft or recoil of the waves.

At Kustendjie the superstructure, founded at 16 ft. below mean low water, is protected on the sea face with large random stone blocks, which extend about 8 ft. above the base of the superstructure.

At Odessa, where the superstructure is founded 22 ft. below mean low water, the rubble base has not required protection.

At Ymuiden, although the superstructure is founded at a depth of 25 ft. below mean low water, the sea face is provided with a wave breaker of large concrete blocks extending above the plane of high water. This added precaution was probably made necessary for the reason that the rubble base was only 3¼ ft. in thickness, and being founded on yielding sand, it became imperatively necessary to protect the sea face from currents which would produce scour and the consequent settlement of the entire work.

With the exception of the Manora Breakwater, the top of which is not above mean high water, we find that even when the base of the superstructure is placed at from 18 to 22 ft. below mean low water it has been considered necessary to give increased assurance to the rubble base by special protection. While the formation of wave-breakers undoubtedly strengthens an otherwise weak superstructure it is highly probable that the expenditure of a less amount of money applied toward placing the foundations at a lower level or in giving increased thickness to the superstructure, would produce better results.

From the foregoing it may be assumed that the best modern practice would place, in localities subject to ocean exposure, the base of the superstructure at from 15 to 22 ft. below mean low water, and even then give the top of the rubble mound additional security by the use of large stone or concrete blocks.

The forces tending to the destruction of a breakwater depend upon the exposure of the site, or in other words, upon the height and velocity of the extreme waves which the work will be required to meet and the angle of incidence of such waves with the breakwater.

At Colombo the direction of the breakwater from the land is N. 10° E., and this direction makes an angle of 30° with the northwest monsoons and 58° with the southwest monsoons. These monsoon winds are of long duration and produce the heaviest seas which have been observed at Colombo. Of the two directions named the southwest monsoons are the most severe, and that of July, 1878, which somewhat injured the work and led to a change in the section of the breakwater, produced waves 15 ft. high from trough to crest and with a velocity of about 35 ft. per second.

At Madras the directions of the breakwaters are S. 72° E., converging by return at angles of 70° with the short arms. The site is more exposed to heavy seas than at any other of the localities under consideration. Besides the monsoon gales, severe cyclones occur in May and November, which impress heavy seas upon the breakwaters. No information is given as to the angle of incidence of the severest storms, but it is stated that waves of over 15 ft. in height are experienced. When the work was nearly completed in 1881 a cyclone from the north severely injured the breakwater by wrecking the converging arms and detaching blocks from the shore-arms of the work. The destruction of the former was caused by the side-long rush of the sea, which disturbed the rubble base, and the displacement of the blocks from the shore-arms was due to the total lack of horizontal bond between the blocks.

At Mormugao the direction of the breakwater is N. 20° E., and the work is fully sheltered from all winds except from the southwest around to the northwest. The heaviest seas arise from the southwest monsoon which strikes the breakwater at an angle of about 30°. The site is much less exposed than Madras or Colombo, but the breakwater has 25% greater width than the former, and in addition is provided with a heavy wave-breaker of random concrete blocks. The plan for the work was designed just at the time that the Madras breakwater had met with its disaster, and HARCOURT considers that the wave-breaker at Mormugao was simply an additional precaution against the experience of Madras.

At Manora the breakwater has a direction of S. 12° E. The severest storms to which it is exposed are the southwest monsoons, which produce waves 15 ft. high, 300 ft. apart and with a velocity of about 30 miles per hour. These waves impinge upon the breakwater at an angle of about 70°. The work was planned for a superstructure about 4 ft. above mean high water, but subsequent settlement reduced its top surface to the plane of high water. On account of this limited height of superstructure the heavy seas pass entirely over the work. During such gales the superstructure has a swaying motion, and even under moderate swells it rocks laterally at the top one-fourth of an inch.

The breakwaters at Kustendjie, Odessa and Fiume, located upon inland seas, present such modified conditions of exposure as to render them of less value than the preceding cases of works exposed to oceanic seas.

At Ymuiden the breakwaters cover the sea end of the Amsterdam Canal, and are built on converging lines from a low, sandy shore. The direction of the northern breakwater is east and west, that of the southern N. 65° W.

To determine the most economical dimensions for a breakwater at any given locality, requires that the maximum exposure be fairly known. Such exposure can not be predicated upon averages, but must take into consideration the effects likely to result from the most fortunate combination of infrequent causes and all tending to produce waves of the greatest possible height and velocity. Such results would not follow from ordinary severe gales, but would rather belong to tidal waves or cyclonic storms. It is also possible that a series of heavy isochronous waves might fall upon a breakwater superstructure so as to induce therein a swaying motion, which would become augmented if the interval of such waves was in rhythm with the movement of the superstructure until the work yielded to the increasing vibrations.

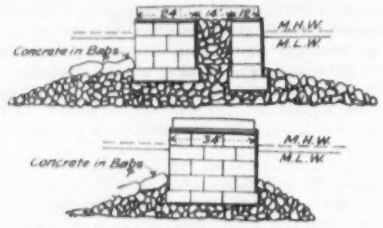
If the exposure at any locality where a breakwater has successfully stood can be fairly compared with the exposure of the locality for which a breakwater is to be designed, then, other conditions being similar, a reasonably safe criterion is obtained. But every new determination must be so largely a question of judgment that, even after the most careful comparisons, assurance of results can not be assumed unless quite a large margin is allowed to cover unrecognized differences of conditions.

In considering the question of the proper dimensions to be given to a breakwater superstructure, more valuable indications are to be obtained from the cases of failures of works than in the successes.

The Madras breakwater, as already stated, failed entirely from an error in the details of construction, by which no bond was given to the blocks of the superstructure in a direction transverse to the axis of the breakwater. The Manora breakwater contained the same source of weakness, but its reduced

height (the plane of high water) saved the superstructure from a fate similar to that of Madras.

Of the remaining breakwaters which have been considered, Colombo furnishes the only case of partial failure which could be used as a valuable indication of the necessary section of a breakwater to withstand the action of an exposure similar to that of Colombo. As originally designed, the breakwater was rectangular in section, with the dimensions shown on sketch. Figs. 1 and 2.



Figs. 1 and 2. Colombo Breakwater.

The breakwater was given a width of 50 ft., so as to utilize the top as a quay. This width of 50 ft. consisted of a sea-wall 24 ft. thick, hearting-wall of rubble-stone 14 ft. thick, and a harbor-wall 12 ft. thick. In the construction of the work the sea-wall was kept about 700 ft. in advance of the harbor-wall.

In July, 1878, when the breakwater had attained an extension of about 1,300 ft. from the shore, and when the 24 ft. thick sea wall was 700 ft. in advance of the harbor wall, an unusually heavy southwest moonsoon caused a horizontal displacement of the outer end of the advanced sea-wall "to the extent of 15 ins., pivoting on a point 150 ft. landward, and lowering the outer end 12 ins., diminishing to nothing 450 ft. inshore. . . . The signs of weakness which indicated the inadequacy of the sea wall to sustain unaided the thrust of the sea" led to a modification of the hitherto adopted plan. The use of the breakwater as a quay was abolished, because it was found that the waves swept over the top of the work with too much force to permit its use for such a purpose. The failure of a superstructure 24 ft. in thickness to withstand the shock of the seas had been demonstrated; consequently the further progress of the sea wall was delayed until the harbor wall could be brought up to its outer end. Then the dimensions of superstructure were modified by omitting the rubble hearting between the sea and harbor walls and uniting the two walls in one section 34 ft. in thickness. This width was continued for the remaining 3,000 lin. ft. of the breakwater.

At the time of this failure of the sea wall the top of the concrete blocks had not yet been covered with the monolith of concrete 4 ft. in thickness, which after all settlement had ceased was finally placed so as to unite the top of the blocks. Although an increased stability would have been given to the wall by this concrete capping, yet, on the other hand, the added height of 4 ft. would have subjected the superstructure to an increased displacing force from the waves. This experience at Colombo was most valuable, and indicates that under a similar exposure the thickness of the superstructure to insure stability must be something greater than 24 ft. With the wall 34 ft. in thickness, no difficulty has subsequently occurred, and of course it is not demonstrated that a less thickness than 34 ft. would not have insured stability. The failure of the wall when 24 ft. thick and the success of the wall when 34 ft. thick simply indicates that somewhere between these limits assured stability was reached.

In general terms, the superstructure of the breakwaters of Colombo, Madras, Mormugao, Manora and Kustendjie consisted of superposed blocks of concrete arranged in a series of sections, each free to settle in planes transverse to the axis of the breakwater independently of the other sections and without the disruption of any bond between these sections, and yet each massive enough to withstand the shock of the seas. The general plan of these superstructures is shown in Figs. 3, 4, 5, 6 and 7. The transverse planes of the sections are inclined to the horizontal at the angles shown. The superstructure of the breakwaters of Odessa and Ymuiden consists of concrete blocks laid in horizontal courses as ordinary bonded masonry. The superstructure of the Fiume Breakwater, in part, consists of concrete in mass deposited in frames in the water, so as to make a monolith of the entire superstructure.

DIMENSIONS OF BLOCKS.

Locality.	Height, feet.	Depth, feet.	Length, feet.	Weight tons.
Colombo	6	5½	8, 9 and 14	17 to 30
Madras	8	4½	12	27
Mormugao	8	4½	13 and 17	28 to 30
Manora	8	4½	12	27
Kustendjie	6	5	12 to 18	20 to 30

At Colombo each sloping section of blocks was prevented from transverse movement by five joggles, consisting of oblong grooves formed in the blocks and filled subsequently with concrete in bags. These grooves were 18 ins. in a direction at right angles to the axis of the breakwater and gave for each set of sloping blocks a united cross-section of 225 sq. ft.

At Madras the blocks of each sloping section are connected by a mortise and tenon 4½ ins. wide and 2½ ins. deep, formed on the top and bottom respectively of each block, but no attempt was made to connect the sea and harbor rows of each section or the several sections together.

In the revised plans for the extension of this breakwater provision is made for clamping together the upper pair of

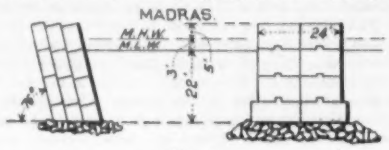


Fig. 3.

Fig. 4.

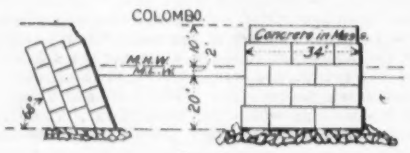


Fig. 5.

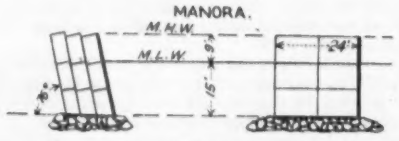


Fig. 6.

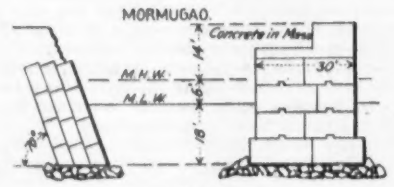


Fig. 7.

blocks. This lack of transverse bond was the cause of a part of the injury to the breakwater which occurred in 1881.

At Mormugao similar mortises and tenons were used to those described for Madras, and in addition a rectangular vertical joggle, 15 ins. square, connected each pair of blocks of the upper two courses. The upper pair of blocks were further secured together by 2-in. square iron clamps and a dowel of iron 7 ft. long penetrating 3½ ft. into the upper pair of blocks. See Fig. 8.

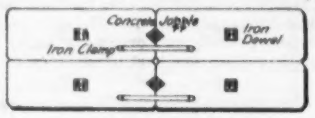


Fig. 8. Fastenings at Mormugas.

At Manora no attempt was made in any way at first to connect the sections of blocks. Subsequently, when it was found that the action of the sea displaced the upper blocks, an attempt was made to add to their stability by inserting stone dowels between the top blocks and the block immediately below. The breakwater still remained as two independent walls placed side by side without even a connection at the top between them.

At Kustendjie the blocks extended entirely through the wall in single pieces, and no attempt was made to connect the blocks of each section, or the sections together.

The general arrangement of joggle bond between the blocks at Colombo not only connects the several sections, but also the individual blocks of each section and seems to be an evolution from the methods which had preceded. Mr. KYLE, the resident engineer of the Colombo works, stated before the Institution of Civil Engineers that while the system adopted worked well, it was still open to improvement.

In the Colombo, Madras (revised), Mormugao and Kustendjie breakwaters the top of the blocks, after settlement had ceased, were tied together by a monolitic mass of concrete for the entire width of the superstructure and from 4 to 6 ft. in depth. Such a mass of concrete, besides securing the upper blocks, protected the top of the work from the pounding action and sweep of the seas, and largely removed the danger of injury from the compression of air or water in the upper joints of the blocks.

At Kustendjie, where the sections of blocks were laid at an angle of 48° with the horizontal, there was a tendency for the toe of the lower block to slip ahead, finally producing a concave slope to the transverse section of the superstructure. From the sketch it will be seen that the plane of the foot of the lower row of blocks was at right angles to the face, and in setting the lower blocks supporting rubble stone was required to be placed under the base of the block. This would naturally leave the block with a tendency to settle outward and finally produce the concave slope described.

At Mormugao there was a slight tendency for the angle of the slope to flatten and become concave at the second or third courses above the base. It will be seen from the cut that the lower face of the lower blocks was a compromise between the forms used at Kustendjie and later works.

At Colombo, Madras and Manora no such tendency toward the slipping of the lower blocks and consequently flattening of the slope is alluded to in the description of these works.

At Colombo the ultimate settlement of the tops of the blocks was from 8 to 18 ins. This was allowed for by keeping the outer end of the work slightly higher when first laid. At Madras the settlement was from 6 ins. to 4 ft., the latter being over a yielding bottom of sand and mud. At Manora the settlement was excessive, and was from 3 to 4 ft. At this locality the deposition of the rubble mound but slightly preceded the construction of the superstructure, and its settlement was not complete before the superstructure was added. In addition to this the sand bottom yielded to the rubble to an unexpected degree. At Mormugao the settlement of the superstructure was from 1½ to 2 ft. and quite even in extent.

The principle of using sloping blocks arranged in more or less vertical sections independent of each other, was devised to overcome the difficulty adhering to settlement and the resulting dislocation of blocks bonded and arranged in horizontal planes. Again, in the system of ordinary horizontal bond the outer end of the work required to be left in an unfinished condition from the necessity of stepping back the successive courses of masonry on each other. With the system of sloping blocks, the outer end of the work is at all times in a closer and more secure condition.

The sloping block system was first adopted at Manora in 1870, and directly afterward at Kustendjie, then at Madras, at Colombo, and lastly at Mormugao in 1880.

Mr. VERNON-HARCOURT, in discussing the various forms of breakwaters, says: "The mixed system (an upright wall founded upon a rubble mound) will probably have the most extended application; and of all varieties of the type the best appears to be a superstructure founded some 20 ft. below low water upon a simple rubble base, formed of large concrete blocks laid with overhanging cranes upon the sloping block principle, securely connected vertically and horizontally, and capped with concrete in mass after settlement has ceased."

A brief allusion may be of interest in this connection to the cases of superstructure, consisting entirely of concrete in mass, deposited in frames and forming a monolithic mass.

As applied to breakwaters, this method of construction has been used at Aberdeen, on the east coast of Scotland, Fraserburgh and Buckie, on the northeast coast of Scotland, Newhaven, on the English Channel, directly south of London, and at Fiume, on the Austrian frontier of the Adriatic Sea.

At Aberdeen South Pier the substructure consisted of blocks of concrete laid as masonry with the ordinary horizontal bond, and carried to a height of about 4 ft. above the plane of mean low water. Upon this is reared the superstructure of concrete-in-mass. At Aberdeen North Pier, Fraserburg and Newhaven the substructure was formed by 50 to 100-ton bags of concrete deposited from a hopper barge and brought to a height of 3 or 4 ft. above mean low water, and upon this the concrete-in-mass superstructure was placed.

At Buckie the breakwater extends to a depth of 10 ft. at mean low water. The bottom is rocky and uneven, and the breakwater is entirely of concrete deposited within frames lined with jute cloth.

At Newhaven the substructure consist of 100-ton bags of concrete deposited from hopper barges. The substructure is brought 3 or 4 ft. above mean low water, and upon it is reared the superstructure of concrete in mass which was deposited in frames. The filling of a section of the frames was commenced at low water and usually carried on ahead of the rising tide.

At Fiume a breakwater was commenced in 1849, whose superstructure was built with concrete-in mass founded on a rubble mound at a depth of 22¾ ft. below the water surface. The locality being on an arm of the Adriatic Sea is greatly sheltered. The concrete was deposited in bottom less frames secured to piling and in sections about 31 ft. in length. Fiume furnishes the only case of a breakwater consisting of a concrete in-mass superstructure founded upon a rubble-stone base. In subsequent breakwater extension the plan was modified to that of a simple rubble mound surmounted above high water with a concrete parapet.

At all these localities the breakwaters are used as quays.

The advantages in using concrete in mass or in bags are mainly confined to small works which would not jus-

tify large expenditure for plant, or to localities where stone is scarce and the foundations are firm.

The disadvantages of the system are, that it is not suitable for irregular settlement; it requires that the locality should be sufficiently sheltered to permit the use of piling and sea staging; it requires the use of larger proportions of cement; it introduces an element of uncertainty as to the character of the concrete below the surface of the water, and it does not permit the utilization of the labor force except at times of comparatively calm weather.

In setting concrete blocks two methods have been used, viz.: from staging, and from cranes. The great advantage possessed by cranes over staging upon exposed sites is, that while the latter must be left exposed to storms, the former can always be run back into shelter. And although the first cost of suitable cranes for handling heavy blocks is quite large, their use dispenses with the great labor, ultimate cost, and delay incident to the use of staging.

The advantage seems so entirely in favor of cranes that they have practically taken the place of staging in modern works. At Kustendjie alone staging was used, but the total length of the breakwater was only 253 lin. ft., and the work would not have economically carried any large expenditure for plant.

Composition of Concrete Blocks at Various Localities.

Locality.	Cement.	Sand.	Gravel.	Stone.
Aberdeen	1	4	5	....
Kustendjie	1	2⅛	....	5⅛
Manora	1	4	5¾	3¼
Ymuiden	1	3	5	....
Colombo	1	2	....	6
Mormugao	1	2	1	6
Alderney	1	1	4	40*
Wick	1	1	2	4
Dublin	1	2	5	....
Madras	1	2	....	7¼

*Per cent.

The parts above used are by volume.

The authority of the best practice in work of this kind seems to be the use of Portland cement for the manufacture of concrete blocks in proportion of about 1 to 8; in which sand occupies 2 parts, with gravel and 2½-in. broken stone for the remaining 6 parts. If gravel or clean shingle can not be economically obtained the 6 parts of broken stone is divided into 4 parts broken to pass through 2½ to 3½ in. rings and 2 parts clean-screened stone broken to ¾ to 1½-in. cubes.

Under Mr. KYLE's experiments at Colombo, concrete blocks of the latter composition, viz. 1 cement, 2 sand, 6 broken stone, gave after three months an average tensile strength of 41 lbs. per sq. in. of section and a crushing strength of 4,231 lbs. per sq. in. of section.

To such a mixture of concrete, hard rubble-stone was afterwards added to the extent of about 40% of the entire volume while the material was being placed in the molds. Care was taken that none of this rubble-stone came within 4 ins. of the surfaces of the blocks.

At Colombo the molds were removed after 3 days, and 3 weeks after the blocks could be set. At Manora the blocks were from 3 to 4 weeks old. At Mormugao when about 3 weeks old, and at Kustendjie when 2 weeks old.

In connection with the cost of concrete in blocks the cost of concrete in bags and in frames is appended. The prices given, as in the case of concrete blocks, are exclusive of the cost of plant and superintendence.

Locality.	Proportion of concrete.	Cost in bags.	Cost in frames.
Fraserburgh	1:5; 1:7	$6.34	$5.06
New Haven	1:8	5.82	5.00
Sand Haven	1:6	....	4.32
Aberdeen, North pier	1:7	5.05	4.97
Aberdeen, South pier	1:8	6.12	3.90
Wicklow	1:7	....	4.56

No comparison can be fairly made in the cases given between the cost of concrete in blocks and concrete in bags or frames. In the former cases the work was mainly done in India, largely with native labo and the employment of women, and where expensive freight charges had to be added for cement, tools and machinery. With the latter cases, while the prices for labor may have been higher the labor was undoubtedly more efficient, and the cost of the concrete was in several cases materially reduced by the use of shingle dredged from the site of the work in the improvement of the harbor.

The entire cost of the works at Colombo was $3,274,000, which includes the dredging of the harbor, foreshore reclamation, shore works, and all expenses of administration. The amount given in the table, $2,430,000, was the cost of the breakwater proper, increased by its proportion of general and administrative expenses. The ordinary labor was furnished by prisoners paid at the rate of 37½ cts. per day of 8 hours. Cement, tools, machinery, etc., and skilled labor were brought from England. The stone was brought 12 miles by rail.

The cost of the Madras breakwater, $2,402,000, contains the items of $395,000 for preliminary expenses of surveys, railways, buildings and plant, and $150,000 for superintendence.

The cost of the Manora breakwater, $529,000, contains about $75,000 for plant.

The cost of the Mormugao breakwater, $420,000, contains about $30,000 for superintendence and $133,000 for plant and its maintenance.

At Colombo 166 prisoners working 8 hours per day were able to make 6 blocks per day, and 300 prisoners working 12 hours per day made 12 blocks per day.

The season during which it was possible to lay blocks was about 6 months, during which an average of 125 working days were obtained. The average progress of superstructure during these seasons was 900 lin. ft., or 150 lin. ft. per month, of superstructure 34 ft. wide and from 24 to 28 ft. high. The rate of progress would have been somewhat higher if the blocks could always have been on hand. On one occasion 720 tons were set in 12 hours, which was at the rate of one 30 ton block each half hour. The average rate was about 8,000 tons per working month.

At Madras the superstructure, 24 ft. wide and 30 ft. high, was advanced on the south breakwater at the rate of 900 lin. ft. per season of 6 months, and on the north breakwater at the rate of 770 lin. ft. per season, or about 7,000 tons per month.

At Manora in a season of 4 months containing 92 working days 910 blocks, each 27 tons weight, were set, equal to 710 lin. ft. of breakwater. The average rate per day when work was possible was 10 blocks, or 270 tons per day, or about 6,000 tons per month. The highest rate was 18 blocks per day, but at one time, under very favorable conditions, 6 blocks, or 162 tons, were set in 1 hour and 40 minutes. The rate of progress was usually controlled by the rate at which the top of the rubble-mound could be prepared by the divers.

At Mormugao, with dimensions of superstructures of 30 ft. wide and 30 ft high, the average rate of progress was 109 lin. ft. of superstructure per month. It is stated that the progress could easily have been 200 ft. per month, or 10,000 tons, if the blocks had been on hand ready to lay.

From the foregoing it seems fair to assume that with the blocks on hand and with suitable appliances for handling them that from 8,000 to 10,000 tons of concrete blocks could be placed in a superstructure each working month.

Legal Decisions of Interest to Civil Engineers

Permitting Use of Invention before Patent.—Revised statutes of the United States provide that one who has purchased or constructed, with the knowledge and consent of the inventor, a newly invented machine before the application for letters patent has been made may continue to use it after the patent is granted, and this is no infringement of the patent. Where an inventor constructs and puts in operation his machine for the use of another before he makes application for a patent, by that act he exempts that particular machine from operation of the patent, giving him a monopoly. (Dable Grain Shovel Co. v. Flint, Supr. Ct. U. S., 11 Sup. Ct. Rep., 8.)

Construction of Contract.—Where a railroad company agrees to erect a viaduct over a street and indemnify the city from any and all legal damages, judgements, decree, and costs and expenses of the same or which may be recovered or obtained against said city for or by reason of granting the railroad company the privilege of laying its tracks uuon such street, the company will be liable for a judgment recovered against the city for damage caused to property by the construction of such viaduct. (Chicago B. & Q. Ry. Co. v. City of Chicago, Supreme Court of Illinois, 25 N. E. Rep., 514.)

Fencing Railroad Track in City Limits.—A railroad track is not required to fence its right of way within the limits of a city, town or village; and, where the larger portion of its depot and station grounds are within such limits, the company is not required to fence that part of such grounds extending outside of the city limits, and upon which abuts a platted addition to such city, when it appears that such grounds are constantly used and are necessary for the proper transaction of its business as a common carrier. (Chicago, C., B. & Q. v. Hogan, Supr. Ct. Neb., 46 N. W. Rep., 1015.)

Implied License to Cross Railroad Track.—Where the inhabitants of certain houses situated near a railroad have for years been in the habit of crossing the track, at a certain place, with the acquiescence of the company, such acquiescence amounts to a license, and imposes a duty upon the company as to such persons to exercise reasonable care in running its trains at that place. The law does not require the same degree of care from a girl of 15 years as from an adult, but only such care as can reasonably be expected from one of her age. Where the evidence as to negligence and contributory negligence is conflicting, the question is one of fact for the jury. (Swift v. Staten Island R. T. Ry. Co. Court of Appeals, N. Y., 25 N. E Rep., 378.)

COST OF RUBBLE BASE AND CONCRETE BLOCKS EXCLUSIVE OF COST OF PLANT AND SUPERSTRUCTURE.

			Rubble stone in base.		Concrete blocks.			
Locality. Length.	Total cost.	Gross tons.	Cost per gross ton.	Cost of leveling per sq. yd.	Quantity cu. yds.	Cost of making.	Cost of setting.	Total cost in position.
Colombo.... 4,212	$2,430,000	320,400	$1.63	$1.80	124,984	$2.57*	.....	$2.57
Madras..... 7,836	2,402,000	938,100	.86	.....	202,343	3.77	$0.82	4.59
Manora..... 1,503	529,000	96,700	.86¼	3.00	29,180	4.23	1.04	5.27
Mormugao. 1,176	420,000	79,500	.59	.75	56,900	4.10	.52	4.62
Aberdeen .. 1,050	373,500	.....	.....	.....	22,851	3.15	.97	4.11

*This price includes the cost of setting.

The Fiske Electrical Range Finder and Other Appliances in Gunnery.

In our issue of Sept. 20 and 27, 1890, was published an interesting paper by Lieut. BRADLEY A. FISKE, U. S. N., on "Electricity in Warfare," in which was given a brief description of the new direct-reading range finder invented by Lieutenant FISKE. Besides its great value in naval work, this instrument seems likely to become of some importance to engineers, especially for coast survey work.

The Fiske range finder consists of two telescopes, mounted at each end of a base line as long as can conveniently be obtained, on fixed standards. If these instruments be each pointed at an object, it is evident that it only needs a determination of the angle between the lines of sight intersecting at the object to make computation of its distance possible, since the length of the base line, which forms one side of the triangle, is known. Of course this can be computed if the angle is measured in the ordinary way; but such computation requires time; and as on board ship the range of a moving object is continually changing, the computation must be made instantaneously to be of value for gunnery purposes.

Lieut. FISKE's invention consists in an ingenious application of electrical apparatus to measure the angle between the telescopes and indicate instantaneously upon a dial the distance from them to the object sighted upon. The only thing in the operation of the instrument at all complicated is the electrical apparatus. The accompanying diagram, however, may serve to make clear the working of the instrument.

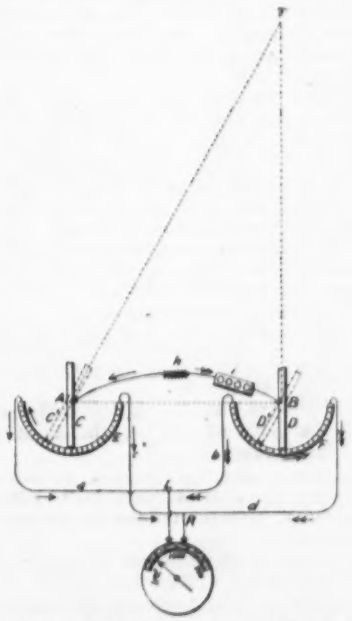


Diagram Showing Working of the Fiske Range Finder.

Suppose *C* and *D* to be the telescopes, mounted at the opposite extremities of a base line *A B*. When trained on an object *T*, whose distance from *A* it is desired to find, the telescope *C* will assume the position *C'*, and the angle *C A C'* will equal the angle *A T B*. But this angle is measured on the semicircular arc *E*, over which the base of the telescope moves; and if it could be read off, the distance *A T* could be readily computed, the base line *A B* being known.

Now comes in the electrical appliances for measuring this arc. At *h* is placed a galvanic battery, from which one wire leads to the pivot of telescope *C* and the other to the pivot of telescope *D*. As these telescopes move over their arcs they maintain electrical contact with them. The arcs themselves are made of material of electric conductivity, and are connected to form a Wheatstone bridge, or (to make it clearer to our readers unfamiliar with electrical apparatus) are so connected as to measure the relative resistance of different parts of the electrical circuit. On the diagram the current from the positive pole of the battery is denoted by single barbed arrows, and the currents from the negative pole by double barbed arrows.

When the telescopes stand in the positions *C* and *D*, the current flows to each telescope, divides at

the point where the telescope touches the arc, half going to the right hand terminal of the arc and half to the left hand, and then passes along the wires, the currents from the left hand ends of the arcs meeting at the point L and from the right hand ends at the point R.

From the junction points L and R, wires lead to a galvanometer. Now, it is a law of electrical circuits that when two paths are open to a current the strength of the current which passes by each is inversely proportional to the electrical resistance of each. Moreover, the electrical resistance of a circuit is proportional to its length. When the telescope C is moved into the position C', therefore, the positive currents from the battery find less resistance in passing around the arc E to the left than to the right; hence the current which passes to the left will be stronger than that which passes to the right. But the negative currents which pass from the battery h to the arc F still divide equally in passing to the right and to the left; hence when the currents combine at the points L and R, there will be a certain remaining positive current at the point L, and a remaining negative current of the same magnitude at the point R, which will pass around the circuit in which is the galvanometer. The strength of this current which passes around the galvanometer circuit is proportional to the angle C' A C, which equals the angle A T B of the right angled triangle having the line A B as the base. But as the strength of the current in the galvanometer circuit is measured by the deflection of that instrument, it is evident that the galvanometer arc may be so graduated that the needle will indicate the angle A T B; or, since the line A T is proportional to the reciprocal of the sine of that angle, the galvanometer arc may at once be graduated to indicate the range A T.

When both the telescopes are parallel they may be considered as directed at an object an infinite distance away; at this time no current will pass around the circuit, the galvanometer will not be deflected, and hence the range indicated will be infinity. Hence, also, short ranges will be indicated by large deflections of the galvanometer.

But in the foregoing explanation we have considered the angle A B T to be a right angle. Clearly this angle is as likely to be obtuse or acute as the angle at A, and so to obtain the range A T we must measure the angle A B T as well. By trigonometry we have $A\ T = \frac{A\ B}{\sin A\ T\ B} \times \sin A\ B\ T$. That is to say, the observer at the galvanometer should multiply the indicated range by the sin A B T to obtain the true range.

In the actual instrument, however, the correction for the sine of the angle A B T is made by the electric apparatus. How this is done may be explained as follows:

In the foregoing explanation it has been assumed that the resistance of the whole circuit remains constant, that is, that it remains the same that it is when the telescopes stand parallel to each other in the position C, D, touching the middle of the arcs. But the resistance of the circuit actually decreases as the telescopes or either of them move either way from this point. The following explanation of how the alteration in resistance of the circuit operates to make the correction for the sine of A B T we copy from the *Electrical Engineer*.

The variation of resistance due to this change of position will affect the total resistance in circuit to an extent depending upon its ratio to the resistance of the whole circuit. And, consequently, if that ratio be made very small, as it easily may be by simply introducing a high resistance in the battery loop at i between the points A and B, then inasmuch as the variation in resistance due to change in position of the telescopes may thus be rendered inappreciable, the total resistance of the circuit may be taken as constant; so that, despite of the fact that the angle, A B T, differs from a right angle, the deflection of the galvanometer, as before, will remain practically constant for any given angle, A T B.

It is evident that if the high resistance before mentioned be not put in the battery loop, then the decrease in resistance due to change in position of the telescopes from the middle point of their arcs toward the extremities of the arcs may bear a considerable ratio to the resistance of the whole circuit. And as this decrease in resistance will be attended by corresponding increase in current strength, it follows that proportionately greater deflections of the galvanometer will follow for any given angle, A T B: so that, consequently, the ranges indicated by the galvanometer will be less than those which would have been shown had the high resistance been put in the battery loop. Again, if the resistance of the battery loop between A and B is extremely small with relation to the rest of the circuit, the decreasing resistance of the whole circuit, due to change in position of the telescopes, may become very large; and this result may be intensified if the members a, b, c, d connecting the arcs are connected to those arcs at points less than 90° from the middle points of those arcs. If, for instance, these wires were connected to the arcs at points 81° removed from the middle points, and if the resistance in the battery loop were one-tenth of the arc of 81°, then when both telescopes were moved to positions 60° from the middle points the resistance of the whole circuit would then be only about half of what it was when the telescopes were at the middle parts, or the positions C, D. Consequently, for any given relative angular displacement of the telescopes occurring 60° away from the middle points of the arcs the corresponding deflection of the galvanometer would be about twice as great as if the same relative angular displacement occurred when the telescopes were near the middle points of the arc; so that the range indicated in the latter case would be about half as great as in the former.

But it will be observed that if the telescope, D, for instance, were 60° removed from the central position, the angle A B T would be 30° or 150°, and then its sine would be ½; so that the range indication for any given angle, A T B, would be only one-half of what it would be with the same angle A T B when the telescope at D' is in its middle position. In other words, the fact of the decreased resistance caused in the circuits as the telescopes move away from the middle position, tends to automatically make the very correction for the sine of A B T which ought to be introduced, because the telescope no longer stands at 90° to the base line; and this is found to be the actual occurrence in practice.

Of course it is essential to the correctness of the above demonstration that the electromotive force and internal resistance of the battery and the resistance of the various contacts remain constant. By using storage batteries and making the contacts carefully the inventor finds that the errors thus introduced may be made inappreciable.

To one not familiar with the accuracy of electrical measurements it seems impossible that such an instrument could give more than a rough approximation of the distance measured. This, however, is not the case. In his lecture before the Franklin Institute about a year ago, Lieut. FISKE reported an error of but six-tenths of 1% in the official trial on board the *Chicago*, using a 200 ft. base line, and it is now stated that on all ordinary ranges the error has been reduced to one tenth of 1%, which, of course, is much greater accuracy than is needed for gunnery work. The Fiske range finder has also been mounted on the *Baltimore*, and Lieut. FISKE is now in England, where a test by the British government will probably soon be made.

The interest of the instrument to engineers is by no means confined, however, to its use in gunnery. That it should already have been perfected to measure with an error of one part in a thousand is most remarkable, and indicates that it may yet be applied with advantage in coast survey work, and possibly even in geodetic surveys, saving all the time and expense of calculation in measuring distances for mapping where no great accuracy is required.

An instrument which promises to be of hardly less importance to modern naval gunnery than the range finder above described is an electric firing instrument and "elevation finder," also invented by Lieut. FISKE. According to the old method of firing on shipboard the gun was elevated to correspond to the range, as near as the gun captain could guess it, was trained on the target, and when both the vertical and horizontal direction were about right the captain pulled the lanyard.

With the vessel rolling and pitching in a seaway, and with the numerous duties devolving upon the gunner, accuracy in hitting was out of the question, except at point-blank range. In fact, the revolution in naval practice by which a few guns of great size have replaced the old "74 gun" vessels of the early part of this century has tended somewhat to make naval bombardments ineffective. Some few of a load of bird shot are generally apt to hit the mark, but a rifle requires careful aiming to be effective.

Returning to the system invented by Lieut. FISKE to take the place of the old methods: In this system the sights by which the gun is trained in a vertical plane are removed, and the gun is mounted with its bore horizontal when the ship is at rest. The usual arrangements for training the gun horizontally are used, and in action it is simply the duty of the gunner to keep the gun properly directed in a horizontal plane. At any convenient position, where the smoke and noise of the gun's discharge may not interfere with steady action, is mounted an ordinary telescope; and the observer who looks through it is the real gunner. The range finder keeps him continually informed of the distance of his target. When the gun is ready for firing he *depresses* his telescope below the horizontal the same number of degrees that the gun should be elevated to correspond to the indicated range. Keeping watch through the telescope he notes the precise instant at which the roll of the ship brings the cross-hairs in the telescope just across the target, at which instant, it will be seen, the gun is at the exact elevation desired. Pressure upon an electric button at his side instantly fires the gun, and the projectile is sent with the greatest possible accuracy toward its mark.

Thus the roll of the ship, which has always been the chief obstacle to accurate firing, is made to give the gun the proper elevation; and the old handspikes, elevating screws, wedges and other mechanical contrivances for elevating the gun in proportion to the range are no longer of use. An exception should be made, however, in case an elevation is desired somewhat greater than the roll of the sea will give. In this case an initial elevation is given the gun; and the ship's roll is relied on for the remainder as before.

This instrument has already been mounted on the *Yorktown*, and, from its simplicity and evident value, seems likely to come into very general use. It will be noticed that the essential part of the invention—placing the control of the gun in the hands of an officer far enough from the gun to avoid confusion, and using the roll of the vessel to give the gun its elevation when it is instantaneously fired—is applicable to guns of any type, with or without the use of range finders. For the particulars concerning this instrument we are indebted to Mr. PARK BENJAMIN, M. Am. Soc. M. E., attorney for Lieut. FISKE.

The Vogel System of Cable Railways.

One of the greatest disadvantages of cable roads, and one that is shared by nearly all of the conduit electric railways, is the expense of constructing the track and keeping it clean and in proper condition. The heavy concrete conduit is always liable to crack and sink when sewers or tunnels are driven below it. The cable system illustrated in the accompanying cuts was designed to eliminate this heavy first cost and at the same time give a solid and clean conduit for the cable.

This conduit, Fig. 1, is formed of steel Z-bars, 10 ins. deep and 30 ft. long, to which is riveted a curved bottom plate of the same length. Triangular yokes

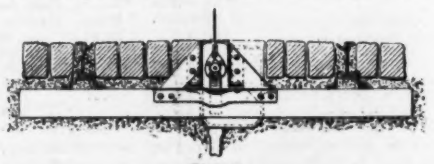


Fig. 2.

are riveted to the sides and bottom of the conduit at intervals of about 3 ft., as shown in Fig. 2. The conduit is supported on the same cross ties that hold the rails, these ties being necessarily placed 10 ins. below the surface, in order to leave room for the paving blocks. The conduit sections can be riveted up complete, including the braces, at the mills, so that the only labor required in the field is to place them on the ties and connect them to the intervening pulley pockets. The sheaves 8 ins. in diameter, with ⅝ in. cold rolled steel axles, run in small cast iron pockets, which may be connected with the sewers, so as to insure a dry conduit.

This form and size of conduit could not be used with the old style of grip, but is amply large for the Vogel grip, which, for the ordinary 1⅛ or 1¼ in. cable, is a cylinder only 4½ ins. in diameter, as shown in Fig. 3.

The cast steel jaws are cylindrical, and revolve about a pin running the whole length of the grip, 20½ ins., in the example illustrated. These jaws have bushings of cast steel or mitis metal, and are moved by toggles attached to the steel body plate,

which is 13¾ ins. wide, and ⅛-in. thick. The steel shanks forming the frame in which the body sheet works, are 3½ ins. wide, and are attached to the steel heads, between which the jaws revolve, by two ¾-in. steel bolts. When the body sheet is raised, the knuckles of the toggle joints are pulled upward,

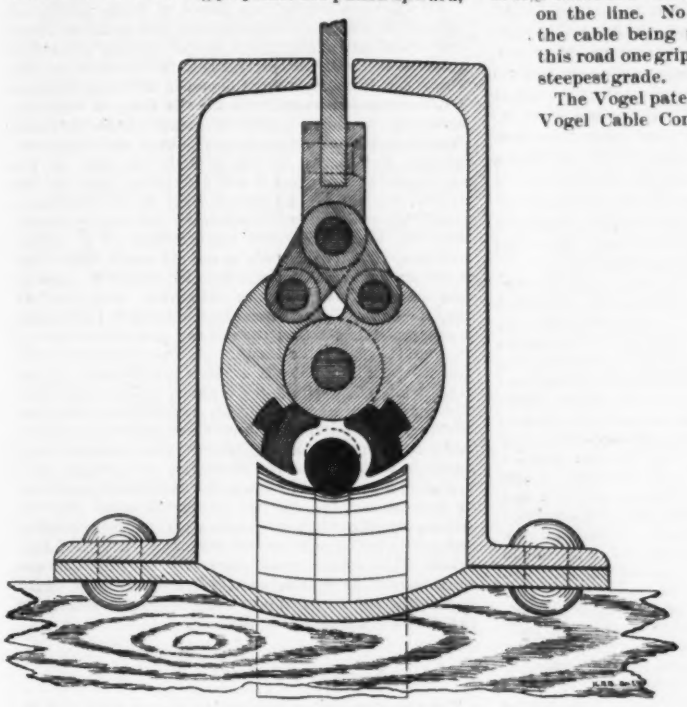


FIG. 1.—METAL CONDUIT.

and the jaws opened; an oposite motion closes them.

Since there are no cable lifts or gypsies used in this system, it was necessary to have some means of picking up the cable even where it sags midway between the sheaves. In order to accomplish this, the grip is carried by 2 posts which rise from the cross bar supporting the grip on the car frame. A cap fits over each post, as shown in the figure, and is prevented from dropping by a heavy spiral spring. A ⅝-in. rod is loosely bolted to the cross bar of the posts and is connected at its upper end with a lever in which the grip itself is centered. The two springs are strong enough to keep the parts firm. When it is necessary to pick up the cable, the gripman presses on the lever, which has a foot plate at the end, and forces the whole grip downward until the open jaws surround the cable, when the grip is closed by a motion of the hand lever.

Mr. CHAS. VOGEL, the inventor of this grip, was engineer of the Powell St. cable road in San Francisco, said to be one of the most difficult lines ever built. He also constructed the Butte City, Mont., road, on his own system, that described above, and embodied many novelties in the design. The line is 1¼ miles long, with double tracks, and is remarkable for being without any level tangents. The grades vary from a minimum of 3% to a maximum of 18%. There is a short tunnel and 2,000 ft. of trestle on the line. No depression pulleys are used, the cable being run on catenary curves. On this road one grip car has hauled 30 tons up the steepest grade.

The Vogel patents are now controlled by the Vogel Cable Construction Co., of New York.

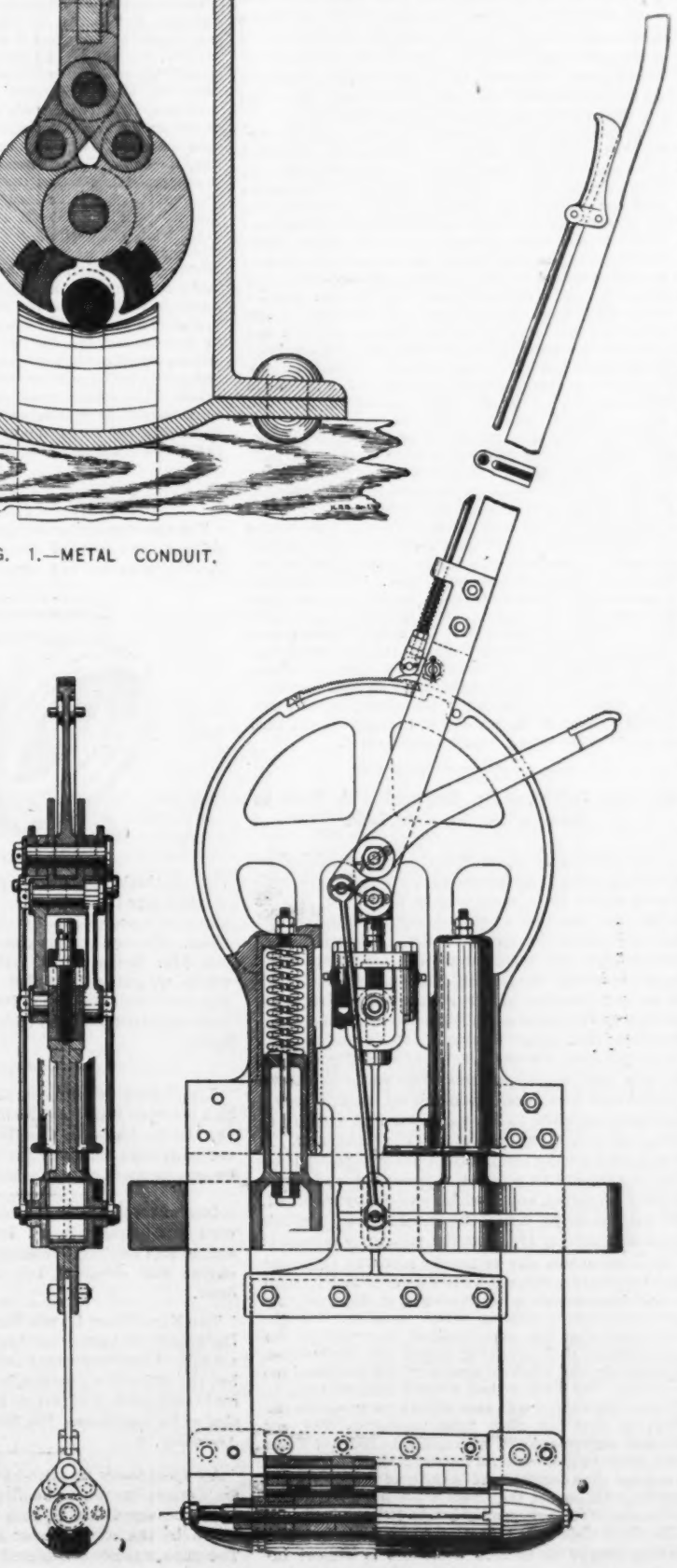


FIG. 3.—THE VOGEL GRIP.

The conduit is the invention of Mr. GEO. S. MORISON, who is also one of the directors of the company, of which Mr. H. D. BUSH is president.

Operating Expenses and Receipts of the Chicago City Railway.

The annual report of President C. B. HOLMES, of the Chicago City Ry., one of the largest street railway corporations in the world, contains some figures of interest to engineers. The company operates 152.95 miles of track, of which 34.19 miles are cable and 118.76 miles are horse lines. The rolling stock comprises 222 grip cars and 1,028 other cars. There are 160 new grip cars under construction. The total number of horses is 2,508. The following table shows the results of the year's operation:

Total passengers carried		68,734,969
Revenue from cable cars	$2,311,455	
" " horse cars	1,125,293	
Total revenue		$3,436,748
Operating expenses		2,297,651
Net earnings		$1,139,097
Interest on bonds	$220,270	
Dividends (four at 3%)	600,000	
Surplus from year's income		318,827

The net earnings, after paying expenses and interest on bonds were equal to 18.37% on the capital stock. The percentage of expenses to earnings was 66.85%, a decrease of 3.72% over 1889.

The following figures are given as to operating expenses:

No. of cable car miles	12,740,480
Operating expenses per cable car mile	9.650 cents
No. of horse car miles	4,859,200
Operating expenses per horse car mile	21.985 cents
Car repairs, per car	$71.49

At the beginning of the year the company owned 2,273 horses. During the year there were purchased 635 horses at a cost of $79,460, an average of $125 per head. The number that died was 132, or one in 20 of the total live stock, entailing a loss of $17,230. Two hundred and sixty-eight horses were sold for $34,854, an average of $130 per head, which was $24,257 less than they cost; making a total loss of horses that died and were sold of $41,487; leaving on hand at the close of the year 2,508 horses.

The daily cost for each horse has been:

	Per day.
For hostlers	19¼ cents.
Feed	15½ cents.
Loss by death or depreciation	4¾ cents.
Shoeing	3¾ cents.
Miscellaneous stable expenses	2⅛ cents.
Bedding	¾ cent.
Repairs for harness	1 cent.

A total of 47 65-100 cents per day.

Where accidents have occurred through carelessness of employees the damage has been collected as far as possible from the parties at fault. In this way $4,222 has been paid into the company's treasury.

The vast difference between suing a corporation for damages by accidents and collecting the amount sued for is shown in the following: In four cases the aggregate amount sued for was $70,000; the courts gave judgment against the company for $8,930; yet the matter was settled after the judgments were obtained by the payment of $1,000 less than the above sum. In 46 other cases the aggregate amount sued for was $515,000, and the cases were settled with a total expenditure of $10,768. For the settlement of 232 other cases in which suit was not brought the company paid $12,102, making a total expenditure in the payment of damages of $30,809.

A notable thing in the records of the company is that for 18 years the road has been operated without a single strike among its employés. During that time the property has grown from 22½ miles of track to 152; the revenue has increased from $600,000 a year to nearly $3,500,000; the speed of the cars has been doubled, and the patronage has grown from 30,000 passengers a day to 200,000.

The Relative Strengths of High Explosives.

Lieut. WILLOUGHBY WALKE, of the U. S. Artillery, has recently communicated to the *Journal of the American Chemical Society* an important paper on the relative strengths of modern high explosives, which is interesting as illustrating the considerable variation in the comparative strengths, not only of different explosives of acknowledged value, but of the same explosive manufactured at different times and under slightly different conditions. It will be recollected that Mr. C. E. MUNROE has already pointed out that the firing point of an explosive is also a very variable number. In his more recent experiments a thin copper cartridge was placed in a molten bath of tin or paraffine, the initial temperature noted by a thermometer, and the bath quickly heated until the explosive

flashed off, when the temperature marked by the thermometer was again noted. The following table shows some of the results obtained:

Description of explosive.	Firing point in deg. C.
Compressed military gun-cotton	186-201
Air-dried " "	179-186
" " "	186-189
" " "	137-159
" " "	154-161
Gun-cotton dried at 65 deg. C.	136-141
Air-dried collodion gun-cotton	186-191
" " "	197-199
" " "	193-195
" gun-cotton	192-197
" "	194-197
Hydronitro cellulose	201-213
Nitro-glycerine	2 3-205
Kieselguhr dynamite, No. 1	197-209
Explosive gelatine	203-209
" " camphorated	174-182
Mercury fulminate	175-181
Gunpowder	278-287
Hill's picric powder	273-283
" "	273-290
Forcite, No. 1	184-200
Atlas powder, 75%	175-185
Emmensite, No. 1	167-184
" No. 2	165-177
" No. 3	205-217

Lieut. WILLOUGHBY WALKE, in his experiments, employed a Quinan pressure gage for registering the pressures developed by the explosives in preference to other methods used by the older investigators, as even the *crusher* used by BERTHELOT gave only approximate results, as shown by MM. SARAU and VIEILLE. The instrument employed consisted of a heavy block of wood bolted to a cast iron base, in which were four iron guides set around a 4-in. circle. A steel plate is let into the iron block flush with its upper surface, and a ring holds the guides in place at the top. The piston is a cylinder of tempered steel moving freely between the guides, and rests on a plug of lead which is to be compressed. The piston weighs 12¼ lbs., and the explosive is placed in a parabola-shaped cavity at its top. The shot was also made of tempered steel, 4 ins. diameter and 10 ins. long, and weighed 34½ lbs.

The instrument is worked in the following manner: The lead plug is placed upon the steel plate, the piston placed gently upon it, and the shot next lowered upon it. The fuse is lighted, and the charge, in exploding, throws out the shot and compresses the lead plug. The accuracy of the test is based upon the assumption that the lead plugs are of uniform density and homogeneous in structure, and the author, by cutting his plugs from bars of pure lead manufactured from large masses of metal at a high temperature, believes that the error from want of these conditions is reduced to a minimum. The amount of compression is finally expressed in foot pounds by plotting the actual compressions measured by the Quinan gage against the work actually done on the lead by known pressures. The author, however, did not plot out his results in this manner, but preferred simply to use the method for determining the relative strengths of the explosives examined, instead of calculating from the observed compressions the absolute pressures exerted. The following table gives a summary of the results obtained, the order of strength being given in numbers, nitro glycerine having assigned to it the value of 100:

Name of explosive.	Compression of cylinder in ins.	Order of strength.
Explosive gelatine (made by Vouge's process	0.585	106.17
Hellhoffite	0.585	106.17
Nitro-glycerine (old)	0.551	100.00
Nobel's smokeless powder	0.509	92.38
Nitro glycerine (fresh)	0.500	91.37
Explosive glycerine (made from above)	0.490	88.93
Gun-cotton (1889)	0.458	83.12
" (1885)	0.458	83.12
Nitro-glycerine (made by French process)	0.451	81.85
Gun-cotton (laboratory)	0.448	81.31
Dynamite, No. 1	0.448	81 31
Dynamite de Trauzl	0.437	79.31
Emmensite	0.429	77.86
Amide powder	0.385	69 87
Oxonite (from pure picric acid)	0.383	69.51
Tonite	0.376	68.24
Bellite	0.362	65.70
Oxonite (picric acid not fused)	0.351	64.94
Rack-a-rock	0.340	61.71
Atlas powder	0.333	60.43
Ammonia dynamite	0.332	60.25
Volney's powder, No. 1	0.322	58.44
" " No. 2	0.294	53.18
Melinite	0.280	50.82
Silver fulminate	0.277	50.27
Mercury fulminate	0 275	49 91
Mortar powder (Dupont)	0.155	28.13

—*Industries.*

The Zone Railway Passenger Fare System for Large Cities.

A recent number of *The Paternoster Review*, an English publication, contained a paper by Mr. E. L. SHELDON in which was advocated the adoption of the zone system for the suburban passenger traffic of large cities in England and the United States. Taking London as an instance, Mr. SHELDON states that there are 10 main lines of railway centering there, and also three purely suburban lines. On the main lines there are about 2,210 suburban trains in and out daily, while the main line trains which are not suburban, are only about 410. In 1889 the 10 main lines carried about 400,000,000 suburban passengers, and the three suburban lines an additional 135,000,000. The suburban traffic includes 272,000 season tickets and 9,000,000 workmen's tickets. The author's idea is to develop the outlying districts by reducing the traveling expenses, and thus to distribute the population more evenly. Within the five mile radius from the center of the city, the street railways, omnibuses and underground railways successfully compete with the ordinary railways, and carry about 453,000,000 passengers per year, but beyond that radius the railways would be practically free from such competition. The plan suggested is to make a uniform fare for all distances and on all lines within a circle of 20 miles radius. The tickets to be sold in packages of 10, 20 or 50, to be transferable, available on any of the main lines and good at any time during the calendar year in which they are sold.

The tickets should be issued by a central authority like the Railway Clearing House, or by a committee appointed by all the railways. They should be of three classes; the third class so cheap as to take the place of the present workmen's tickets; the first and second class cheaper than the present season tickets or excursion tickets. Packages of such tickets would be bought by all now using season tickets or workmen's tickets, and having been bought would be used not only by the head of the family, but very largely by the other members of the family. Human nature looks upon a thing already in possession as of less value than that for which money must be paid out, and thousands of people who would hesitate to pay a shilling to go upon a visit or on business would not think twice about using a ticket of equal value already in their possession. Many tickets would be lost and never presented. Doubtless many at the end of the year would still remain in the hands of the public unused, although it might be good policy on the part of the railways to redeem such. The railway taking up the ticket would receive its value from the central authority issuing it. The system of accounts would be very simple. There would need to be but three kinds of tickets: Zone tickets of first, second and third class respectively, to take the place of the hundreds of varieties now printed for the different stations within the same area. The precautions against forgery in regard to these might be much more elaborate than at present. The railways would be relieved of nearly all expense of the sale of these tickets Shopkeepers would willingly sell them for the convenience of their customers. The item of profit from the loss of tickets alone if sold in packages would be very considerable. Experience in regard to amusement tickets, sold in packages of 20 in the city of Chicago, showed that about 15% of the tickets were never presented.

Railway Collisions in England. A Plan to Reduce the Loss of Life.

The London *Railway Press* recently published an editorial calling attention to the number of accidents which have occurred, in which an express train has run into an engine, car or train that had no business to be on the track. It is pertinently stated that the most interesting, but at the same time dispiriting fact, is that these oft-repeated accidents have invariably taken place where the block system was in operation. The accident on the Great Western Ry., near Taunton, in November, 1890 (ENGINEERING NEWS, Nov. 15), is specially noticed. In this case an up express train ran into a down freight that was standing on the up track, where it had been switched to allow a down fast freight to pass, and had been forgotten by the signalman. It was shown during the Board of Trade investigation that the signalman was an experienced and trustworthy employee, and that he was not overworked, but that he simply forgot the freight train. On this point the *Railway Press* has the following remarks:

The accident was due to human fallibility alone, and till human nature changes we fear we must look forward to similar catastrophes. They are part of the penalty we have to pay for the blessing of fast traveling. The disaster shows that the most stringent observance of the regulations as to interlocking signals and the strictest adherence to the block system must not be trusted too implicitly. The block system without question tends to minimize the number of cases of the kind we are considering, but does not make them impossible. The very feeling of security enjoyed by adopting the Board of Trade rules and the use of powerful modern brakes tends rather to increase than decrease the severity of collisions when once, as in the case of the Great Western signalman, the mechanism of the human mind breaks down.

The Press then calls attention to the fact that the greatest loss of life in such accidents is almost invariably in the car next the engine and suggests that a "parcels" or baggage car should be placed between the engine and passenger cars, as is the invariable custom in this country. This, however, would only afford a safeguard in case of head collisions; but we quote some of the remarks of the above paper as follows:

All who have studied the Board of Trade reports on railway accidents must have noticed that in almost every case of collision at high speed mortal injuries are rarely received except in the carriage next the locomotive; and recent accidents, including the one on the Great Western Ry., have demonstrated, with all the force of carefully arranged experiments, that an express train traveling 50 miles an hour or more can run into a stationary one without serious risk to life or limb, so long as the carriage next the engine is not occupied. Next to the engine, of every express train at least, should be placed a goods van, or any other vehicle which experiments should show to best satisfy the requirements of a buffer carriage. The frame work of an old coach, built over with strong lattice work, would probably answer the purpose as well as anything else, and at little expense. The addition of such a van to their trains would probably not cost the railway companies a penny. It would soon resolve itself into an express parcel van. Its use would be practically confined to non-traders, as the rates would be too high for ordinary commercial firms. The express van would be largely used for the conveyance of game, fish, poultry, eggs, butter, and other country delicacies to London. On outward journeys the contents would approximate to those of the West End emporiums. It is probable, if the Board of Trade would take the matter up in earnest, that the railway companies would offer no serious objection to the compulsory use on their principal trains of a buffer carriage between the tender and first coach. If, however, the companies neglected to act on the recommendation of the Board of Trade, the latter could easily obtain power to enforce their recommendations, as in the case of continuous brakes, etc.

A Large "Special" Castirg.

The accompanying illustration shows what can be done in the way of combining many branches of large dimensions in a single globe special casting.

This particular casting is intended for use with a vertical pipe in a reservoir, and at the same time serves as a connection for a number of distributing pipes. The one casting combines two 24-in. outlets, one 6-in. flange outlet and two 12-in. outlets, the whole weighing 1,500 lbs. It was made at the Builders' Iron Foundry, Providence, R. I., from their standard patterns without any cost for pattern labor.

LITIGATION OVER CAR-HEATING PATENTS has begun between the Consolidated Car-Heating Co. and the Martin Anti-Fire Car Heating Co. The former company sues the latter for infringement of a patent on arrangement of piping in cars.

ONE OF THE AXLES OF A LOCOMOTIVE on the Concord & Montreal R. R. broke Jan. 27 while the engine was hauling a train near Concord, N. H. The engine was derailed, but no other damage was done.

THE NEW YORK RAPID TRANSIT bill passed finally the Senate at Albany on Jan. 28. This is the Stewart bill. Some important amendments were made, but the bill would practically leave the selection of route and method of transit to the present Commission or its successor. The bill has yet to pass the Assembly.

AN EXPLOSION OF FIRE-DAMP in one of the Frick Co.'s mines in the Connellsville district, Pennsylvania, occurred Jan. 27, and over 110 miners were killed by the explosion or suffocated by the gas. The mine was not considered a dangerous one.

PERSONALS.

Mr. R. J. DUNCAN has been elected President of the Union Depot Co., Denver, Col., vice Mr. C. F. MEEK, resigned.

Mr. C. M. AVERY has been appointed Superintendent of Streets of Rockford, Ill., vice Mr. D. C. DUNLAP, resigned.

Mr. M. M. KINNEY, formerly of Cleveland, O., a civil engineer on the Northern Pacific R. R., was killed by a blast at Butler, Mont., Jan. 22.

Mr. C. E. WURTELE has been appointed Superintendent of the Wyoming division of the Union Pacific Ry., vice Mr. F. MERTSHEIMER, resigned.

Major PEYTON RANDOLPH, General Manager of the Richmond & Danville, R. R., has been appointed third Vice-President. Mr. H. W. GREEN, General Superintendent, has been appointed General Manager.

Mr. WM. HOCKING, mining engineer, died at Piedmont, W. Va., Jan. 20.

Gen. MICHAEL B. HEWSON died at Washington, D. C., Jan. 22. He was Chief Engineer of the Mississippi & Tennessee R. R. during its construction, and had also been Chief Engineer of the Mississippi levees.

Mr. F. W. D. HOLBROOK, M. Am. Soc. C. E., late Manager of the Seattle, Lake Shore & Eastern Ry., has accepted the position of Secretary of the new Board of Public Works, of Seattle, Wash.

Mr. ERWIN GRAVES for several years engineer of the Camden Iron Works, Camden, N. J., has resigned his position and gone abroad. He is the originator of a hydraulic traveling crane.

Mr. RUDOLPH HERING, M. Am. Soc. C. E., has been engaged by the city of Wilmington, N. C., to prepare plans and report upon a system of sewerage and sewage disposal for that city. Mr. JOHN C. CHASE, City Surveyor is now making a topographical map of the city and collecting other information for the purpose specified.

NEW PUBLICATIONS.

—*Builders' Hardware.* A manual for architects, builders and house furnishers. By CLARENCE H. BLACKALL, Architect. Boston, Ticknor & Co., 8vo, p. 322, 510 cuts, $5.

This somewhat luxurious volume must certainly "fill a void," not only on the shelves of the architect's library, but of the engineer's also, if he is called to supervise more or less building work, as so many engineers are. The great trouble with a work on its subject must always be that so many novelties are being constantly introduced into "Builders' Hardware" as to make it rapidly become antiquated, unless revised editions are frequent; but while new, at least, a book of this kind has undeniable convenience.

The volume opens with a chapter on the various materials and kinds of surface finish used in builders' hardware, and it will astonish many readers to observe that from 15 to 22 different styles of surface finish are enumerated in the catalogues of the leading manufacturers. Nails and tacks, screws, bolts and hinges are exhaustively illustrated and described in the next four chapters, with not a few practical hints such as this, which will bear repeating: A red hot poker, held against the head of an obstinate screw for a few minutes will so expand and loosen it as to make it easy of removal. The various forms of bolts and hinges are very fully illustrated.

The long chapter on locks is interesting reading for any one, the whole subject being clearly and cleverly discussed, the style of the work throughout, in fact, being very good. Of the ordinary form of Yale lock it is recorded that "assuming a variation of $\frac{1}{32}$ in. in the length of the pin to be enough to lock the plug, 267,331,200 locks can be made on this system, no two of which can be operated by the same key. The various methods by which the principle of the Yale lock has been appropriated, without such close similarity as to constitute an infringement of patent, are curious to study.

Door-springs, checks, hangers, pulleys, sash fastenings, shutter fixtures, transom and sky light fittings, door knobs, closet fittings and miscellaneous hardware are all discussed in fully illustrated articles, the general idea of which is to describe the essential differences of functional construction, rather than mere differences of form, which, of course, are endless. A separate chapter on "Artistic Hardware" discusses this endless field somewhat briefly, but no doubt as fully as it would be profitable to discuss it in a work of this kind, which is not intended as a substitute for the manufacturers' catalogues, but rather as an aid to their intelligent examination.

The closing chapters of the work, "Hardware Specifications," while not long (hardly so long as it should have been perhaps) is an eminently practical one, and the work closes with an excellent and full index. The one serious objection to the work, a very common one among architectural works, is that its cost is needlessly increased by having "a thin rivulet of text meandering through a meadow of margin." For a strictly utilitarian publication of this kind one-third as much paper put into a book at half the price or less would have presented the matter handsomely enough, and probably resulted in three or four times as large a sale, with larger profits to publisher and author. Nevertheless, to many who want just such a work as this, it will be cheap enough at the price.

Structural Steel and Iron Work. By F. STUART WILLIAMSON, C. E., No. 1 Broadway, New York. A neat pamphlet, issued for the information of intending builders, by the author, who is a consulting engineer of long experience both in the office and in the shop.

Seven-year Wet and Dry Periods and Increase of Rainfall in Kansas. By E. C. MURPHY, C. E., Lawrence, Kan. Gives a table of annual rainfall in inches in various parts of Kansas, and commencing, for Leavenworth, only in 1836.

—*Report of the Public Works Department of South Australia for the year ending June 30, 1890.* Published at Adelaide. The report deals mainly with the water supply and well boring for irrigation purposes, and includes extensive tables of financial matters. It has a map showing the location of wells and several plates of sections of borings. The report of the Works and Buildings Department has plans of hospitals and a cemetery. It is recommended that the Water Conservation Department be put permanently under the control of the engineer-in-chief. Mr. A. B. Moncrieff, M. I. C. E., is the present engineer-in-chief.

—*De la Production et l'Emploi de la Vapeur considérée comme Force Motrice principalement dans les Locomotives.*—MM. A. Lencauchez et L. Durant, 8vo, 106 pp., 3 plates. A reprint of a paper published in the proceedings of the Society of Civil Engineers, Paris, in June, 1890. The paper deals with the various points of the production and use of steam. The appendices include notes on the Ten-Brinck firebox used on the Paris & Orleans Ry., and on tests of locomotives on that road.

—*Proceedings of the Sanitary Convention held at Lapeer, Mich., March 27 and 28, 1890.* A supplement to the Michigan State Board of Health Report for 1890. Pamph., pp 71.

About five pages of the report are taken up with data and discussions concerning sanitary matters in Lapeer; the remainder is of a medical and general character.

—*Report of the Railroad Commissioner of Rhode Island,* E. L. FREEMAN, *Commissioner.* Providence, 1891. Cloth bound, 151 pp., with map of Rhode Island.

—*Agricultural Experiment Station, Cornell University.* Bulletin No. XXV. December, 1890.—Contains the results of sundry investigations made during the year at the College of Agriculture connected with above University. The present bulletin discusses the analysis of milk and cattle food, the sugar beet, effect of certain foods on fowls, etc.

TRADE PUBLICATIONS.

Employers Liability Assurance Corporation, of London. American managers, Endicott & Macomber, Boston, Mass. A most charming publication in its typographical appearance, fully setting forth the advantages of the employers of labor insuring against claims for accidents to those employed.

—*Hoisting Machines.* Energy Mfg. Co., Philadelphia, Pa. Illustrated price list of portable rope hoisting machines, elevator gearing and various kinds af hoists.

—*Track Fusees and Torpedoes.* Western Torpedo Works, Fostoria, O. Illustrated pamphlet of red fire signal fusees or torches to be placed on railway track or held in the hands of trainmen. Also track torpedoes. The fusees burn for 5, 10 or 15 minutes, and their light is visible for a considerable distance. They are provided with waterproof lighters, and are not extinguished by wind or rain.

Gaskill Pumping Engine at Schenectady, N. Y. Official report of test by RICHARD M. GIFFORD, M. E. Republished by the Holly Manufacturing Co., Lockport, N. Y.

—*Brick Pavements.* By the Warren-Scharf Asphalt Paving Co. Discusses the advantages claimed for brick street paving as compared with asphalt pavement.

—*Pintsch System of Car-lighting,* by compressed oil gas. Safety Car Heating & Lighting Co., 160 Broadway, N. Y. A handsomely printed pamphlet, illustrated by photogravures chiefly showing where this system is now in use.

—*Elmira Steam Generator.* Office in Elmira, N. Y. Pamphlet illustrating and describing this really simple device, and giving testimony of users as to benefits derived.

—*Smith Vertical Water Tube Boiler, with vertical tubulous shell.* Office, 210 E. Lexington street, Baltimore, Md. Record of experiments and tests of this rapid steam producer, with illustrations and description.

—*Street Pavements.* Report of Mr. A. H. Mitchell, of Cincinnati, O., to the taxpayers of Avondale, O., giving answers to his enquiries, regarding the character of pavement adopted, from various city engineers and city officials. The queries called for the choice between vitrified brick and asphalt pavement, and the latter is evidently preferred in the letters published here.

SOCIETY PROCEEDINGS.

The Rensselaer Society of Engineers has elected the following officers: President, W. B. Hammond, '80; Vice-President, H. H. Rousseau; Corresponding Secretary, T. J. Foster; Recording Secretary, M. J. Thompson; Librarian, A. M. Foster.

Montana Society of Civil Engineers.—Fourth annual meeting, held at Helena, Mont. The following officers were elected for 1891: President, Elliott H. Wilson; Vice-Presidents, John Herron and George H. Robinson; Secretary and Librarian, James S. Keere, of Helena; Treasurer, Alnash S. Hovey; Trustee, Walter W. de Lacy.

Engineers' Society of Western Pennsylvania.—The annual meeting was held at Pittsburg, Jan. 20. The treasurer reported receipts $1,730.30, and expenditures $1,610 61. The secretary reported a membership of 370. The retiring president, Mr. W. L. Scaife, read his address, and a paper on "Description and Operation of an Electric Coal Plant" was presented by Mr. C. F. Scott. The following officers have been elected for the current year: President, Col. T. P. Roberts; Vice-President, A. E. Hunt; Secretary, J. H. Harlow; Treasurer, A. E. Frost; Directors, Geo. S. Davison and Thos. H. Johnson.

The Ohio Society of Surveyors and Civil Engineers.—Meeting at Columbus, O., Jan. 21, 22. President J. T. Buck in the chair, about 75 members present. The president, in his annual address, reviewed the whole history of surveying. After the routine business and presentation of committee reports, the following papers were read: "What Knowledge Should be Required of Surveyors to Qualify for Practice," C. N. Brown, Prof. Civil Eng., O. S. U.; "Land Surveying," G. S. Innis; "Transit Points," John L. Culley; "Sewer Plans for Dayton," F. J. Cellarius; "Notes on Construction of Sewers," Charles A. Judson; "Brick Paving," H. L. Weber; "Measure," D. W. Pampel; "Separate System of Sewers," J. B. Weddell; "Stored Power of the World," Dr. Edward Orton, State Geologist. A resolution was adopted approving of the recommendation that the State levy a special tax for the aid of the Ohio State University. The legislature is also to be petitioned to establish standard time in Ohio. The following officers for 1891 were elected: President, Thomas R. Wickenden, Toledo, O.; Vice-President, Samuel Bachtell, of Columbus; Secretary and Treasurer, E. D. Wileman, of Massillon, and five trustees.

Michigan Engineering Society.—The twelfth annual convention was held at Lansing, Mich., Jan. 20, 21 and 22, President J. B. Davis presiding. At the first session an informal discussion was held on land surveying. In the evening the president delivered an address on "Roads." Among the causes for the general awakening of interest in the subject of better roads, he mentioned the action taken by the League of American Wheelmen, the increase in business, the fact that roads are becoming more and more the channels for the distribution of the necessities of life, and that they serve as feeders to railways, increase the value of real estate, etc. Professor Davis stated that as the subject can be put upon a business basis, what is needed is to show railway and business men and farmers that it is promoting their best interests to establish good roads. Among suggestions made in the paper and the discussion were the following; To place the management in the hands of a competent engineer; surrender of toll roads; classification of roads in use; continual, maintenance and repair instead of periodical fixing; foreign assessment system by which the user pays according to weight of load; legislative action; employment of prison labor, etc.

The treasurer reported receipts, $604.44; disbursements, $542.87; balance, $73.54.

In the succeeding sessions papers or addresses were presented on the following subjects; "That Problem in Surveying," by F. Hodgman. Members were referred to ENGINEERING NEWS of Dec. 6, 1890, for several other excellent solutions besides the one presented by Mr. Hodgman. "Restoring Lost Corners," by Burton Kent; "Engineering for Lumbermen," by A. J. Teed; "Use of the Gradienter," by F. Hodgman; "Sandstones of the Upper Peninsula," by H. G. Rothwell; "Robert Clark, Jr., U. S. Surveyor," by O. H. Todd; "Maps for Assessors' Use," by E. L. Hayes; "Who Owns the Lake Beds," by F. Hodgman; "Notes on a New Form of Contour Caliper," and "Behavior of Wood under Repeated and Varying Stresses," both by Prof. W. F. Durand; "Laying Sewers in Quicksand," by William Appleton; remarks and blackboard illustrations and data on "Iron Tests," by Prof. Chas. E. Greene; "Erection of the Grand River Bridge on the Michigan Central R.R.," by B. Douglass; "Thatcher's Spiral Boiler," by G. S. Williams; "Paving Bricks," by G. M. Ames; "The Explorer and His Work in the Copper Regions," by J. H. Forster; "Surveying in the Northern Territories," by Prof. C. S. Denison. The following officers were nominated for the ensuing year: President, Prof. W. F. Durand; Vice-President, Geo. E. Steele; Secretary and Treasurer, F. Hodgman.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Civil Engineers' Society of St. Paul.—Next meeting, Feb. 2. Secy., G. L. Wilson.

Rensselaer Polytechnic Institute Alumni.—Midwinter reunion at Kansas City, Mo., Feb. 2 and 3.

Western Society of Engineers.—Next meeting, Feb. 8. Secy., J. W. Weston, 230 La Salle St., Chicago.

Denver Society of Civil Engineers.—Next meeting, Feb. 8. Secy., Geo. H. Angell.

Civil Engineers' Association of Kansas.—Next meeting, Feb. 4. Secy., J. C. Herring, Wichita, Kan.

Engineers' Club of St. Louis.—Next meeting, Feb. 4. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting, Feb. 4. Secy., Francis Collingwood, 127 E. 23d St., New York.

Technical Society of the Pacific Coast.—Next meeting Feb. 6. Secy., O. von Geldern, 408 California St., San Francisco.

Engineers' Club of Philadelphia.—Next meeting, Feb. 7. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Club of Cleveland.—Next meeting, Feb. 10. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Feb. 11. Secy., F. M. Curtis.

Engineering Association of the Southwest.—Next meeting, Feb. 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—Next meeting, Feb. 13. Secy., D. W. Meeker, St. Paul, Minn.

Western Railway Club.—Next meeting, Feb. 17. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 17. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Feb. 18. Secy., S. E. Tinkham.

Northwest Railroad Club.—Next meeting, Feb. 19. Secy., H. P. Robinson, St. Paul, Minn.

New York Railroad Club.—Next meeting, Feb. 19. Rooms, Hilsey House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Feb. 9. Secy., J. F. Wilson.

WE desire to secure information as to the efficiency of steam ejectors for raising water. Can any of our readers give us particulars of any careful tests of steam ejectors, or give any figures of the consumption of fuel or steam and the work done in actual service in any case, from which computation of the efficiency could be made? We should also be pleased to receive particulars of any cases where ejectors have been used to force water against especially high pressures.

THE United States has now become the greatest iron producing nation of the world, having produced 9,202,703 gross tons of pig iron in 1890, against about 8,000,000 gross tons produced in Great Britain, an excess of about 1,200,000 tons, or 15 per cent. This result was predicted six months ago, but has only this week become a certainty. It has been attained by the most astoundingly rapid development of a vast industry which the world has ever seen, our pig iron product having increased from 4.04 millions in 1885 to 9.20 millions in 1890, an increase of 5.16 millions or 128 per cent., during which period the British product inceased only from 7.42 to 8.00 million tons, or about 7.8 per cent. Since 1882 when the British product was the largest on record, the two countries have compared as follows:

Year—Gross tons.	Gt. Britain.	United States.	p. c. incr.
1882	8,586,680	4,623,323	....
1883	8,529,300	4,595,510	— 0.6
1884	7,811,727	4,097,868	—10.9
1885	7,415,469	4,044,526	— 1.3
1886	7,009,751	5,683,329	40.5
1887	7,559,518	6,417,148	12.9
1888	7,998,969	6,489,738	1.1
1889	8,245,336	7,603,642	17.2
1890	8,000,000?	9,202,703	21.0

While "doubtful things are mighty uncertain" there would appear to be little probability that the British pig iron product will ever again be so large as the American, but rather a strong probability that the American lead will continue to increase. For the British product had been growing rather slowly up to its maximum of 1882, and the record since gives every indication of its having then reached about its natural maximum, which it is not likely to exceed again very soon. On the other hand, in the United States the pendulum has never yet swung very far back again after one of these great advances, the rule being that the ground gained in periods of rapid advance has been nearly all held, the reaction being comparatively small and temporary. The present stock of pig iron is not abnormally large, and while it is yet far too soon to predict positively, there is little present probability of any decrease in production during the current year, but rather an increase. Our natural advantages for producing pig iron are great, and by the end of this decade and century it will not be at all surprising if our normal pig iron product is twice as great as the British, and more than half that of the whole world. It is already nearly if not quite 40 per cent. of the world's production.

THE rail making interests of the country are now concentrated in the hands of the following six great companies:

	Tons yearly capacity.
Illinois Steel Co., Chicago, Ill.	925,000
Carnegie Bros. & Co., Pittsburg, Pa.	600,000
Lackawanna Steel & Iron Co., Scranton, Pa.	450,000
Cambria Iron Works, Johnstown, Pa.	225,000
Pennsylvania Steel Co., Steelton, Pa.	200,000
Bethlehem Iron Co., Bethlehem, Pa.	200 000
Total capacity	2,600,000

In 1880 there were 10 different rail making concerns, and 9 others have built mills since, but, by a process of absorption or abandonment, these 19 concerns have been consolidated into the above 6, which are the only ones now engaged in the production of steel rails to any noticeable extent. Some of these companies, as notably the Illinois Steel Co., control several different and widely works, and it would seem to be but a single step more, and a comparatively short and easy one, to concentrate all these companies under a single management. Already there is a tacit understanding among them which prevents cutting of prices and insures division of orders, and the concerns are now so few and so intelligently managed that there is little more likelihood of an outbreak of war among them than if they were consolidated in a formal "trust." Together these concerns produce something like $60,000,000 worth of product annually, or an average of $10,000,000 each. In 1890 the shipments of the companies amount to 1,388,000 gross tons, only half the rated capacity of the works.

In 1880 the steel rail production of the United States was only 852,196 tons, produced by 10 concerns. Nearly twice the product is now produced by little more than half as many companies, illustrating the irresistible tendency toward consolidation of modern industry in a few hands. It is plainly all but hopeless for any new concern to attempt to enter the field in competition with the older established organizations, which now enjoy a practical monopoly within the range of price, at which rails can be imported.

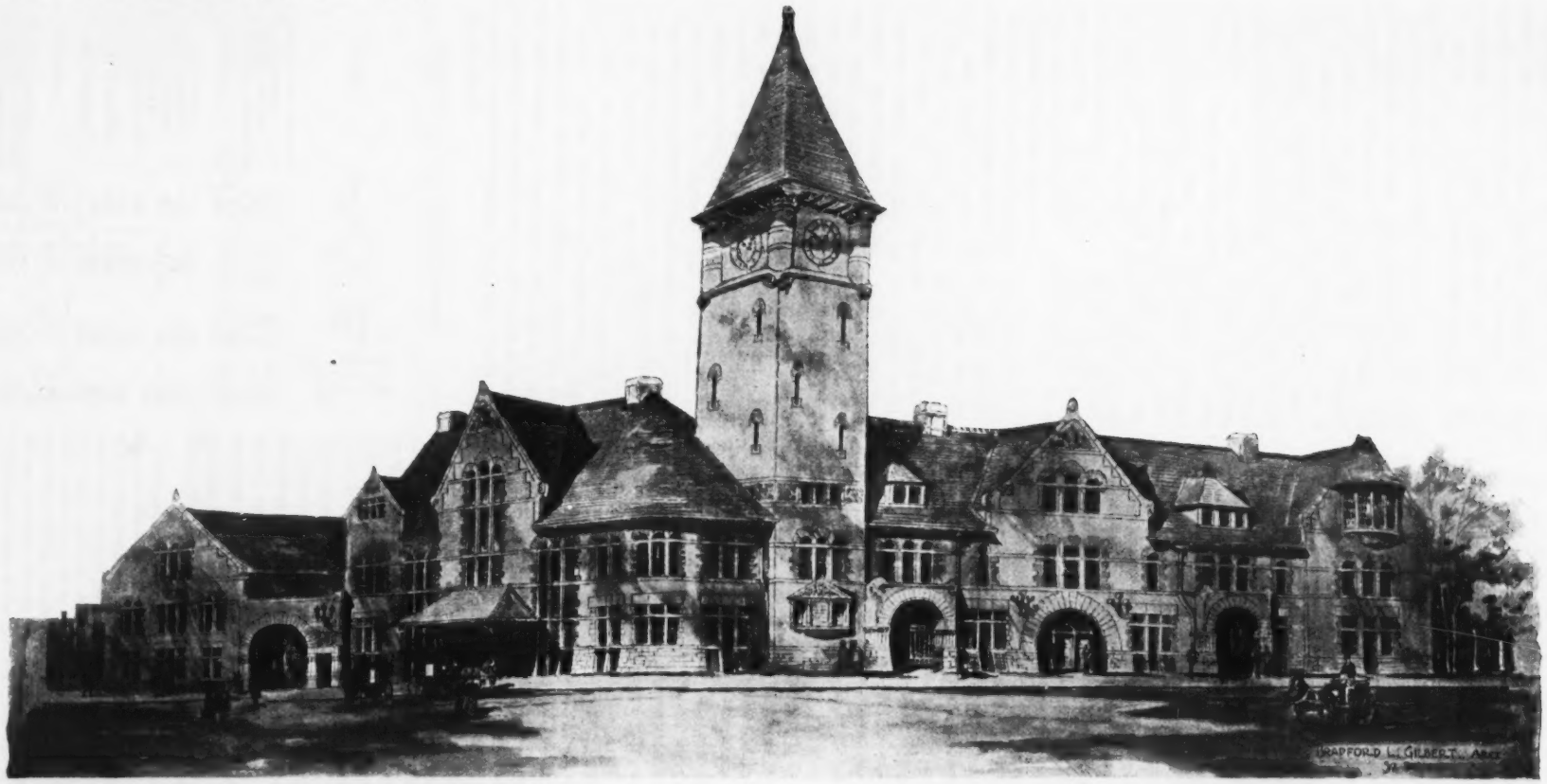
Problem of Flying.

In our issue of Aug. 31, 1889, we published an article under the above head, discussing the general problem of aerial navigation, with the resulting conclusions that (1) little or nothing could be hoped for in the way of making the ordinary balloon dirigible, for the reason that as soon as driven against the wind at any considerable speed it would be so distorted as to become unmanageable; and (2) that a flying machine of the bird type, in which dynamic energy and not buoyancy is the sustaining element, was almost equally hopeless until man could so far approach to the perfection of the animal mechanism as to obtain in small motors some approach to 100 per cent. instead of barely 3 to 4 per cent. of the theoretical energy of the fuel. Our conclusion was, therefore, that the only immediate hope for a practicable flying machine seemed to be one which was dirigible only within the limits of an electric conductor by which it was continuously supplied with electricity from the earth. In this way the two greatest obstacles to aerial navigation are overcome, viz., the necessity of carrying a great weight of fuel and water, and the need for a very heavy prime mover, since an electric current can be converted into mechanical energy with 80 to 85 per cent. efficiency, and by a very light motor.

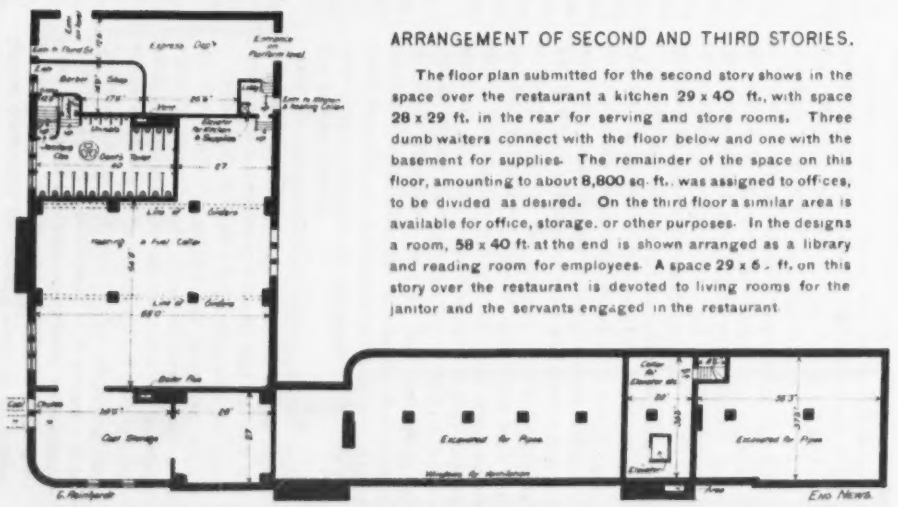
Nothing which has appeared since has seemed to demand modification of the substance of these conclusions, but on the other hand we have since learned that more had been accomplished in the direction of dirigible balloons than we were aware of at the time, or than seemed to us then to be possible. A recent lecture before the students of Cornell University by Mr. O. CHANUTE contains, perhaps, as complete and accurate a summary of progress to date in aeronautics as has yet appeared; and, although we published at the time a brief abstract of this paper, we now abstract more fully those parts of it which appear to supplement or conflict with the views expressed in our former article.

Mr. CHANUTE first divides the problem of flying into two parts, which we may call "aeronautics," or the art of navigating the air, aided by the bouyancy of gases lighter than air, and "aviation," or the art of flying as the birds do, by mechanical power only, with a structure heavier than air.

So far, the only real successes have been obtained by the aeronautic type. The French military balloon *La France*, between August, 1884, and September, 1885, made seven different voyages, in five of which the balloon was returned to the point whence it came; speeds of 10 to 14 miles per hour in still air being attained, by a screw 23 ft. in diameter, driven by a force of 9 H.P. Messrs. RENARD and KREBS were the officers in charge of the tests. The resistance to motion



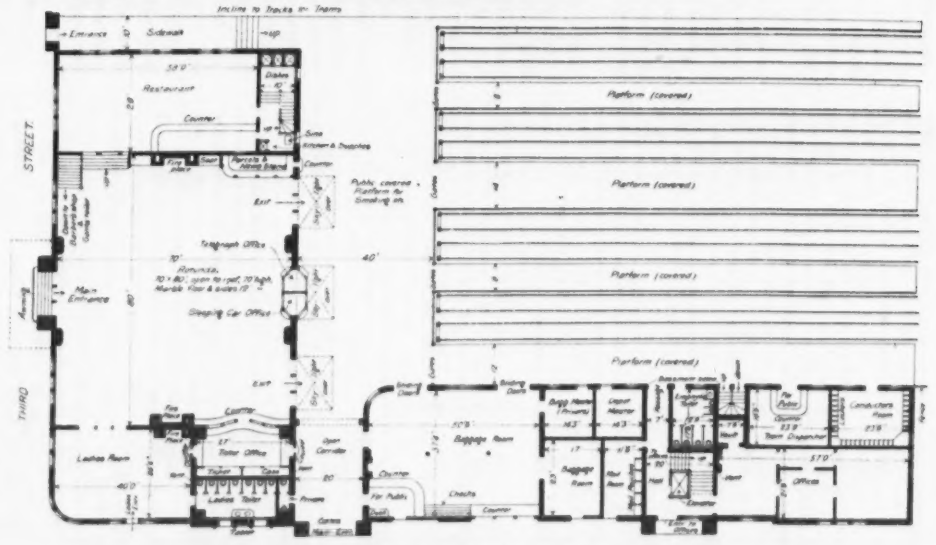
DESIGN FOR THE FORT ST. UNION DEPOT AT DETROIT, MICH. Bradford L. Gilbert, Architect.



PLAN OF BASEMENT.

ARRANGEMENT OF SECOND AND THIRD STORIES.

The floor plan submitted for the second story shows in the space over the restaurant a kitchen 29 x 40 ft., with space 28 x 29 ft. in the rear for serving and store rooms. Three dumb waiters connect with the floor below and one with the basement for supplies. The remainder of the space on this floor, amounting to about 8,800 sq. ft., was assigned to offices, to be divided as desired. On the third floor a similar area is available for office, storage, or other purposes. In the designs a room, 58 x 40 ft. at the end is shown arranged as a library and reading room for employees. A space 29 x 6 . ft. on this story over the restaurant is devoted to living rooms for the janitor and the servants engaged in the restaurant.



PLAN OF GROUND FLOOR.

of this balloon at a speed of 20 kilometers (12.42 miles) per hour, was computed* to be about 1,045 lbs., from which it would appear that some 35.3 HP. was necessary to drive it at the stated speed. We do not attempt to reconcile the inconsistency with the stated horse power of the motor, but this corresponds very closely with the figure which we deduced in our former article by analogy with windmill practice, viz., that 33⅓ HP. acting on a 25-ft. wheel would develop a lifting force of 782½ lbs.

The prior successes which have been achieved with dirigible balloons are summarized by Mr. CHANUTE as follows: In 1852 HENRI GIFFARD, the future inventor of the injector, drove a spindle-shaped balloon at 4.3 to 6.7 miles per hour with a 3-HP. engine, using coke as fuel. In 1855 he made a further trial with a larger balloon, but his balloon became almost unmanageable from "longitudinal instability," as a soap bubble might if driven against the wind, and he and his companion came near to losing their lives. In 1881, after GIFFARD had become rich and famous, he again proposed to build a gigantic balloon air ship, to contain 1,766,000 cu. ft. of hydrogen, and cost $200,000, out of which he expected to get a speed of some 45 miles per hour. But his health and eyesight were failing, and he preferred to commit suicide in a simpler and less expensive way.

GIFFARD was a great engineer, and this practical exhibition of his faith, after his two early experiences, will justly be regarded as making the dirigible balloon a more hopeful direction for experiment than we were disposed to regard it in our former article, especially as two other semi-successful experiments have been made in this line besides those heretofore noted, viz., one by M. DEPUY DE LÔME, Chief Naval Constructor of France, during the siege of Paris in 1872, and one by M. GASTON TISSANDIER in 1883. The Dupuy de Lôme balloon was driven by man power, and the Tissandier balloon by an electric battery weighing 517 lbs., and capable of developing 1½ HP. for 2 hours. The main details of all four of the successful experiments so far made, and the only ones which have become matters of record, are embodied by Mr. CHANUTE in a subjoined table, but in addition to those recorded experiments a great number of others have been made since 1885 by French military engineers, the nature and results of which have been made a profound mystery, but which are understood to have been much more encouraging than any which are as yet of record.

SCHEDULE OF NAVIGABLE BALLOONS.

DATA.	Giffard 1852.	Dupuy de Lome, 1872.	Tissandier, 1883.	*La France*, Renard & Krebs, 1884-85.
Length, out to out.....ft.	144.3	118.47	91.84	165.21
Diam., largest section... "	39.3	48.67	30.17	27.56
Length to diam., proport'n.	3.67-1	2.43	3.04	6
Cubic contents.....ft.	88,300	120,088	37,439	65,836
Ascending power.....lbs.	3,978	8,358	2,728	4,402
Weight—				
Balloon and valves.... "	704	1,255.5	374	812
Netting and bands.... "	330	396	154	279
Spars and adjuncts.... "	660	1,316.5	75	170
Rudder and screw..... "	.....	165	.....	193
Anchor and guide rope "	176	308	110	.....
Car complete..... "	924	1,287	220	935
Motor in work'g order. "	462	2,000	616	1,174
Aeronauts..... "	154	310	330	308
Ballast and supplies... "	567.6	1,320	849	471
Total apparatus..... "	3,977.5	8,358	2,728	4,402
Horse power of motor.....	3	0.8	1.5	9
Weight motor per HP., lbs.	154	2,506	410	130
Speed obtained—miles p. h'r	6.71	6.2	6.71	14
HP. req. 25 miles per hour.	155	52(?)	77	51
Motor pounds per HP.....	3	38(?)	8	23

As the ultimate limit of speed which as yet appears possible for dirigible balloons, Mr. CHANUTE suggests that one of twice the dimensions of *La France*, *i. e.*, 350 ft. long and 55 ft. in diameter, may attain a speed of 25 miles per hour, with a motor of 182 HP., weighing as much as 130 lbs. per HP.: and this corresponds closely with what Commandant RENARD, from his great experience in charge of the official French experiments, declares to be in "in sight."

This may do well enough for military purposes, where one or two passengers only are desirable, and may open a great field for the use of dirigible balloons in that direction, but for any kind of commercial or general use it holds out no promise of usefulness, and it would seem to be the utmost which it can ever be hoped to accomplish by means of vast gas bags lighter than air.

It is not so with the flying machine proper, which flies as the bird flies, by mechanical power only. Two papers on this subject were presented at the International Congress of Aeronauts and Aviators, held in Paris in August, 1889; one by Mr. O. CHANUTE, of which we hope shortly to give an abstract, relating more to the theory of the subject, and one by a Russian engineer, M. DRZEWIEKI, embodying a great mass of practical details.

These two papers agree in this, that the sustaining power in a plane inclined but slightly above the horizontal is very much greater than has been heretofore supposed. M. DRZEWIEKI deduces that the minimum of resistance to forward motion, while yet retaining a sufficiency of sustaining power, is 1° 50′ 45″, which he assumes as the angle of flight. Mr. CHANUTE deduces by a different line of investigation that the angle lies between 1° and 2°. M. DRZEWIEKI demonstrates (or attempts to do so) that the bird is not really sustained by flapping its wings, but solely by this upward reaction due to its speed, and that it flaps its wings merely to get speed.

M. DRZEWIEKI then shows by a table of the proportions of 64 birds that the smaller the ratio of sustaining surface to weight the greater is the customary speed, the range being from 7.56 sq. ft. per lb. for the bat, which flies at some 20 miles per hour, to 0.43 sq. ft. per lb. for the duck, which flies at 60 miles per hour. He estimates that for a speed of 90 miles an hour 0.22 sq. ft. per lb. would suffice. whence an area of 10 ft. square would sustain 455 lbs.; and he further computes that a well designed flying machine sailing at an angle of 1° 50′ 45″ will require only 5.87 HP. per ton, or 1 HP. per 340 lbs., to drive it at 25 miles per hour, Mr. CHANUTE, having computed that the pigeon uses 9½ to 10½ HP. per ton to fly at the same velocity. What is still more important, instead of the power required increasing as the cube of the speed, as with a balloon or a ship, it is computed only to increase in the direct ratio of the speed, so that to increase from 25 to 50 miles per hour means only doubling the horse power.

Allowing only 10 HP. per ton, and only one-fourth of the total weight to be devoted to the motor, we readily obtain 50 lbs. per HP. as the heaviest admissible motor for an entirely independent flying machine. Mr. CHANUTE compares this with the actual weights of engines as follows:

The machines in common use, being designed chiefly for strength and durability, are needlessly heavy, and it is only by inquiring into what has been done for special purposes that we shall get an idea of their possibilities. Thus as to steam engines: Ordinary stationary machines weigh with boilers from 500 to 1,600 lbs. per HP.; locomotives, from 200 to 300 lbs.; marine engines for Atlantic steamers, 480 lbs., and light launch engines—those of HERRESHOFF, for instance—some 60 lbs. per HP. For aeronautical purposes, however, a steam engine was built by STRINGFELLOW, which weighed but 13 lbs. and exerted 1 HP., and another was built by MOY & SCHILL of 3 HP. and 80 lbs. weight, thus being about 27 lbs. per HP.

But these weights, while including the boiler, do not include the water and fuel. These supplies may be estimated at 22 lbs. of water and 4 lbs. of coal per hour, so that if a large engine can be built as light per HP. as that of STRINGFELLOW (13 lbs.), it would still need, if for so short a trip as two hours, 52 lbs. of supplies per HP., making a total of 65 lbs., including the engine itself.

Gas and petroleum engines, as now made, are excessively heavy, weighing from 280 to 1,000 lbs. or even more per HP., so that the advantages of dispensing with the boiler and its water supply are completely lost. They are comparatively of recent invention, however, and it is believed that corresponding reductions of their weight can be made. A three-cylinder petroleum engine has been built for marine purposes in France which develops 5 HP. and weighs but 440 lbs., thus being in the ratio of 88 lbs. per HP. It consumes, as near as may be, 1 lb. of petroleum per HP. per hour.

Electric motors involve, like the steam engine, two separate parts, the motor proper and the generator, which latter may be either a primary battery or an accumulator.

The weights of the motors or ordinary dynamos used in this country run from 92 to 260 lbs. per HP. developed, while abroad they run from 68 to 350 lbs. per HP.; but the special dynamo used by Commandant RENARD weighed but 26.4 lbs. per HP., and a very small one, built of aluminum by M. G. TROUVE, weighed at the extraordinary rate of but 7.6 lbs. per HP.

M. TROUVE is now building for the Portuguese government a 10 HP. dynamo, which will weigh less than 220 lbs., and which is to be used to drive a navigable balloon. The total weight of the motor, batteries for several hours of work, screw and accessories, is estimated at 1,496 lbs., or at the rate of 149.6 lbs. per HP. developed.

Contrary to expectation, accumulators are found, by comparison of numerous data from various makers, gathered by M. TISSANDIER, to be actually heavier than primary batteries. As they are charged to last various periods of time, it is necessary, in order to compare them, to reduce them to the common standard of 1 HP. *for* 1 hour, and it is then found that accumulators of the best make weigh from 107 to 162 lbs. per HP. per hour, a fair average being 135 lbs.; while the primary battery of Commandant RENARD is stated by himself to weigh but 66 lbs. per HP. per hour, and to last a little over 10 hours, this being the present possible length of his trips.

It will be seen that no form of motor yet devised weighs so little as 50 lbs. per HP., including its necessary supplies of fuel and water or battery; but on the other hand, that it is possible to construct an electric motor which shall weigh only 8 or 10 lbs. per HP. This tends to support to the suggestion above noted that the true direction for immediate effort in the direction of navigating the air is to use a cable connection with an electric conduit on the surface of the earth, allowing to the flying machine freedom of motion only within the "length of its tether," which might be considerable, and more or less invariable.

Granting any given speed per hour in still air to be possible in this way, such a machine could keep its course against any gale blowing in any direction, of less speed than its own limit, simply by pointing its nose in the right direction.

A moderate success in this field of experiment is already "in sight" by the use of known appliances, and except for two great obstacles it would probably have been already attained in some measure. The first and greatest of these obstacles is that for military purposes the balloon type is much preferable, in that it requires no connection with the earth, and readily permits of slow speed or no speed at all. The second obstacle is that experimental flying through the air is likely to be exceedingly dangerous at first, and certain to be expensive, with little or no chance of reaping a profit from the expenditure by producing anything more than a scientific toy for many years after the first partial success.

Still, the prospect of such a triumph over nature is of itself enough to inspire the necessary enthusiasm, once a beginning is made, and in this age of rapid development a beginning may be made any day which will attract the attention of the world and cause rapid progress thereafter. It is much less improbable that some toy of this kind will be a feature of the exposition of 1893 than was the transmission of speech by the telephone three years before the exposition of 1876 opened. It appears to us that the first significant successes are likely to come by direct experiment with aeroplanes, discarding the gas-bag element altogether, but Mr. CHANUTE reaches a different conclusion, which he expresses as follows:

Success with aeroplanes, if it comes at all, is likely to be promoted by the navigable balloon. It now seems not improbable that the course of development will consist, first

* R in kilograms = 0.01685 D^3 V^6, in which D = the diameter of the (cigar shaped) balloon in meters, and V = the speed in kilometers per hour.

in improvements of the balloon, so as to enable it to stem the winds most usually prevailing, and then in using it to obtain the initial velocities required to float aeroplanes. Once the stability of the latter is well demonstrated, perhaps the gas bag can be dispensed with altogether, and self starting, self-landing machines substituted, which shall sail faster than any balloon ever can.

If we are to judge of the future by the past, such improvements are likely to be won by successive stages, each fresh inventor adding something to what has been accomplished before; but still, when once a partial success is attained, it is likely to attract so much attention that it is not impossible that improvements will follow each other so rapidly that some of the present generation will yet see men safely traveling through and on the air at speeds of 50 or 60 miles per hour.

More New England Notions About Car-Couplers.

There is something well nigh inexplicable in the pronounced and practically unanimous hostility of the railway mechanical officers of New England to the Master Car Builders' standard coupler. Here are little more than half a dozen companies, controlling, all told, a smaller mileage of railway than is comprised in a single one of the great Western systems. None of them have ever put the M. C. B. coupler into use on their own cars so far as we can find, except the New York & New England, which did equip 106 local box cars in 1889. There are also 200 cars equipped with the Hien couplers on the Housatonic, and in the report of the New England Railroad Club proceedings, published last week, we notice that the Boston & Maine did once upon a time test the vertical plane coupler by equipping *one car* with said device. One of the couplers broke. Hence, said Mr. CHAMBERLAIN, "we did not buy any more."

Practically, then, the experience of the New England roads with the M. C. B. coupler has been confined to handling such foreign cars equipped with it as happened to pass over their lines. Leaving this experience for later discussion, let us see what the mechanical officers of roads which have had large experience with the vertical plane coupler think of the matter as shown by their acts. In the following table we give figures for whose reliability we can vouch, showing for a few roads the number of cars equipped with M. C. B. couplers in December, 1889 (at the time of publication of our first map showing progress in the brake and coupler reform), and also on Jan. 1, 1891. We have selected, it will be noticed, roads in various localities; and while the list includes some of the largest users of the M. C. B. couplers, the list shows but a small part of the M. C. B. couplers actually in use:

	Length in miles.	No. of cars equipped with M C.B. couplers in Dec., 1889.	1890.	Inc.
Chic., Burl. & Quincy.....	2,060	815	2,513	1,698
Chic., R. I. & Pac.....	3,300	2,200	3,000	800
Cleve., Cinn., Chic. & St. L.	2,023	1,800	4,100	2,300
Grand Rapids & Ind.....	572	225	500	275
Lake Shore & Mich. So'n...	1,410	1,700	2,287	587
Lehigh Valley.....	1,078	1,350	3,550	2,200
Penna. (whole system).....	6,750	8,928	10,262	1,334
Richmond & Danville.....	3,020	3,857	4,151	294
Total	20,233	20,905	30,363	9,458
Total all New England Rys.	6,730	?	?	

From the above table it appears that eight companies, controlling some 20,000 miles of railway, and having about a year ago over 20,000 cars equipped with M. C. B. couplers in use on their roads, were so well satisfied with the device that they have increased the number of cars so equipped during the past year some 45 per cent.; and yet the mechanical officers of several New England roads who do *not* own a car equipped with M.C.B. couplers declare that it is "the most dangerous thing" in railroad service; and they are all anxious to adopt rules boycotting all cars equipped with the device.

As for the experience which some of the New England roads claim to have had with M. C. B. couplers on cars belonging to other companies, Mr. ADAMS presented at the meeting reported last week some very remarkable figures concerning the breakages of couplers on the Boston & Albany. This is not the first time that Mr. ADAMS has made public figures showing a remarkable slaughter among M. C. B. couplers on the Boston & Albany. Mr. ADAMS was a member of the committee which at the Minneapolis Convention of the Master Car Builders' Association in 1887 reported in favor of the adoption of the Janney type of coupler as the standard. Notwithstanding this he has since been an active enemy of the coupler. Those who care to read Mr. ADAMS' previous statements as to his woful experiences with the M. C. B. couplers may refer to our issues of March 22, May 3 and June 7, 1890. Until Mr. ADAMS condescends to make some answer to certain pertinent queries addressed to him in the last of the issues above referred to, any fair-minded man will be apt to place little reliance on his records of M. C. B. coupler breakages.

One other matter referred to by another speaker deserves a little comment. It was explained that the M. C. B. coupler had been "foisted upon the railroads by the mechanical papers," not only by their advertising columns, but by "procuring the writing of editorials." It is indeed a sad commentary on the intelligence of such men as Messrs. ELY of the Pennsylvania, RHODES of the Chicago, Burlington & Quincy, KIRBY of the Lake Shore & Michigan Southern, and a host of other men of similar prominence and reputation as railway mechanical officers that they have been so imbecile as to permit the technical journals to foist upon them a device by tens of thousands which good judges (who have never tried it) declare to be the "most dangerous appliance in the railroad business," as well as the most expensive.

The seductive pictures in the advertising pages, Messrs. RHODES, ELY and the other misguided men might have withstood; but when the hungry and impecunious editor was "procured" by the naughty car coupler manufacturers to write an editorial and "make the managers believe the M. C. B. coupler was a panacea," these mechanical officers, heretofore noted for cautious conservatism, were really obliged to succumb, and not only try the device, but adopt it as a standard, and equip thousands of cars with it!

Certainly these sharp Down East Yankees do well to periodically congratulate each other that they have been cute enough to see through the subtle attempt of the railway journals to foist this device upon them. Other deluded people may consider the New England roads "unprogressive" as one speaker at the New England Railroad Club meeting plaintively feared; but that cannot matter much, since they know that they are in the right, and that it is the fellows out West who are so green as not to see through the evil machinations of patentees and railway journals.

The example of the New England roads and the precepts of the New England officials would be more impressive, however, did not history record that a similar outbreak of cuteness kept them partisans and adherents of the plain, old-fashioned style of passenger coupler, and the good old plan of braking by hand, and the time-honored practice of running trains by time-table instead of by telegraphic orders for years after the rest of the country had almost forgotten that these antique methods ever existed. The same infirmity must have its way now, we suppose. Like the measles, it compels an unpleasant isolation while it lasts, but in the end the patient returns to the ranks of other healthy and rational beings. On the whole, after looking over a few statistics which we intend shortly to present, we conclude that the M. C. B. coupler is strong enough to defend itself with its own knuckles against any number of New England Railroad Clubs.

Since the above was in type we have received some interesting drawings, which we present in another column, and which those who believe that the M. C. B. coupler has increased the dangers of coupling cars will do well to examine.

The main indictment, however, which the valiant defenders of the link and pin bring against the M. C. B. coupler is based on the claims that its breakage is enormous. In our issue of Feb. 15, 1890, we presented statistics covering the breakages of 45,617 M. C. B. couplers of the Janney type, in use on 11 different railways. From these statistics the total average cost of maintenance of Janney couplers, so far as breakages are concerned, was computed to be 29 cts. per car per year to the railways and 46 cts. per year in addition to the McConway & Torley Co., we having taken into consideration the standing offer of the McConway & Torley Co., manufacturers of the Janney coupler, to replace free all drawbars broken through defects in the material or manufacture, and give one new knuckle for each two broken ones returned. It may here be said that Mr. ADAMS, whose sensational statements as to the breakages of M. C. B. couplers we have noticed above, has steadfastly refused to take advantage of this offer, thereby losing for his company, if his statements be accepted as correct, several hundred or thousand dollars per annum.

This astonishingly small sum of 29 cts. per car per year, cost to the companies, we stated to be probably too low a figure for the maintenance of couplers after being some time in service. But the McConway & Torley Co., manufacturers of the Janney coupler, as may be noticed in our advertising columns, now stand ready to guarantee to any railway company so desiring that the cost of maintenance of the Janney coupler on its cars shall not exceed a very moderate sum for a term of years. They offer to assume themselves the maintenance of the Janney coupler, entering into a five-year contract at a fixed annual rate of *one dollar* per car per year, with privilege to *the insured* to withdraw from the contract at the expiration of any one year. Of course the cost of correspondence, bookkeeping, traveling and inspection makes it necessary for the McConway & Torley Co. to charge a considerably higher rate for this insurance than the bare cost of maintenance to the railway companies, especially as the only roads likely to take advantage of the offer are the small and unimportant ones equipping few cars. The sum charged is, therefore, as low as any reasonable person could expect.

It will be really interesting to see what the few bellicose opponents of the M. C. B. coupler will find to say against it now. Its cost of maintenance need no longer terrify the timid, since they are guaranteed by a responsible company that the total cost shall not exceed $1 per car per year for five years, which is probably less than the average cost of maintenance of the link and pin coupling.

Fortunately the obstructive policy of the New England railways toward this reform can have comparatively little effect on the policy of other roads, and it cannot long be maintained. The influence of the State Railway Commissions and general public opinion, with the growing influence of employees' associations are all certain to be exerted in favor of automatic couplers and against the link and pin. The final outcome will be the same as with other modern innovations against whose introduction the New England railways made such resolute resistance, but whose benefits they now see as clearly as any one.

CORRESPONDENCE.

Compound Locomotive Tests.

LOS ANGELES, CAL., Nov. 14, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Answering your comments on my previous letter, published in your issue of Nov. 1, the statement that the engine must have realized an efficiency of nearly 90% will, I believe, be found to be correct. The tests give the steam pipe pressure at 139 lbs., and the diagrams show a terminal pressure of 24 lbs., and an exhaust against a back

pressure of 4 lbs. per sq. in. Under these conditions the maximum work due from 1 lb. of steam would be the equivalent of about 140 B. T. U. (The expression "about 140" is used because that quantity was determined graphically and is therefore liable to the small errors of scaling due to such methods).

The record of tests states that the cards accounted for 92% of the feed water; therefore, the weight of steam passing through the cylinders was 19.19 lbs. per I. HP. per hour, and the total heat available for work would be $19.19 \times 140 = 2,686.6$ B. T. U. One HP. per hour is equivalent to 2,564.77 B. T. U. To have developed this amount out of a possible 2,686.6 required an efficiency of 95½%. Considering the small margin this provides for loss between the steam pipe and piston, loss from condensation unbalanced by re-evaporation, losses from radiation, convection, leakage, etc., it may perhaps be thought reasonable to say that the reported results seem "scarcely credible."

Is it a fact that it has been shown that compounding locomotives reduces the weight of steam used from 15% to 20%? Is it not that these figures rather refer to the saving of fuel, attained under favorable circumstances, and represent the combined effect of engine and boiler? Independent testing of boilers and engines, as suggested previously, would add largely to a knowledge of the subject.

H.

[We must apologize to our correspondent for unintentional delay in the publication of his letter. Precisely what can be said to have been "shown" in any conclusive way by compound engine tests we could not undertake to say; but many tests purport to have demonstrated experimentally a saving of 15% to 20% due to the compounding alone, independently of the saving in fuel. On the other hand, other tests of like general nature show about the same economy in fuel, leaving it undetermined whether it is due to more efficient combustion or more efficient use of steam.—ED. ENG. NEWS.]

The "Soo" Water Power Canal.

DETROIT, Jan. 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The newspaper statements in regard to the water power canal at the "Soo" from time to time have always given me much amusement, and this is especially the case concerning the close of a short article I noticed reprinted in your paper.

They speak of the excavation works for 10,000 HP., when they cannot realize 5,000, and the increase to 30,000, which would probably amount to 10,000. But the cream of all is the statement that by widening and deepening the tail race they can get 100,000 HP. if required in the future. My measurements of the outflow of the St. Mary's River (1868) gave in round numbers 92,000 cub. ft. per second, and the total fall is a little less than 18 ft. So that the total power of the whole rapids, both American and Canadian, is $92,000 \times 62.3 \times 18 \div 550 = 187,579$ HP.

Their canal is about three miles long, and they would lose about a foot a mile to maintain velocity to prevent freezing, so that they would have to widen and widen enough to take in the whole river in order to realize the horse power mentioned. This would be rather bad for navigation and would make Lake Superior a *mare clausum*. How foolish for the American and Canadian governments to go to such expense in the construction of canals and locks when as soon as this English syndicate requires the 100,000 HP. they will run dry. Yours truly,

D. FARRAND HENRY.

The Designers of the Phœnixville Testing Machine.

PHŒNIXVILLE, Pa., Jan. 22, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the description of the 1,200-ton testing machine of the Phœnix Iron Co., published in your issue of Jan. 10, we find the name of Mr. AMORY COFFIN, Chief Engineer, a gentleman who had no part in designing the machine, while the names of the writers and designers are omitted.

The undersigned were instructed by Mr. DAVID REEVES, President of the Phœnix Iron Co., to design and construct a testing machine on the same principle as the one built by Messrs. KELLOGG and MAURICE, of Athens, Pa., but capable of breaking by tension a steel bar 12 ins. × 3 ins. in section, and also of testing to the breaking point, by compression, the compressive members of bridges of large size.

Upon consultation, we concluded there was left us but very little room for improvement in the details of the machine, as designed by Mr. CHAS. KELLOGG; and we do not, therefore, desire in the least degree to detract from the credit due to that gentleman. In fact, we took pains to exhibit the drawings to him, and desired that he should consider our close adherence to his design as a compliment.

We simply claim for ourselves the credit of having followed an excellent model, and having designed such changes as were necessary to increase the capacity as a tension machine and to enable it to act also as a compressive machine.

Our connection with the machine included also the specifications, inspection, erection, boring apparatus necessary for boring the stop pin holes in the girders after the girders were in place, the hydraulic apparatus, and the building and roof covering the machine.

R. H. DAVIES, late Master Mechanic.
JESSE HALL, Mechanical Engineer.

[We give space with pleasure to our correspondents' claims to recognition in connection with the design of what is, so far as we are informed, the most powerful testing machine in existence. The omission to give credit to them in the original description was wholly unintentional, and in justice to Mr. COFFIN it should be said that he took no credit whatever to himself for the design of the machine. Nor is he stated to be the designer in our published article. We simply acknowledged his courtesy in furnishing to us the blue prints and information from which our article and illustrations were prepared, as is our usual custom.—ED. ENG. NEWS.]

Slide Rules and the Thacher Calculating Instrument.

PHILADELPHIA, Pa., Jan. 10, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Referring to your mention of the Mannheim slide rule, I would ask if, in stating it to be the best slide rule, you meant to include in the comparison Thacher's calculating instrument? Thacher's instrument, while it actually is a slide rule, is quite different in design and appearance from the ordinary slide rule, and I think perhaps you did not mean to include it in the statement referred to. From a description of the Mannheim slide rule, which I have received this morning, it does not appear to me to be equal to the Thacher machine for the uses of an engineer.

F. H. LEWIS.

[The two instruments are not really comparable. The Thacher instrument is really nothing more than an elongated slide rule cut into parallel parts surrounding (and on) a cylinder, so as to bring the whole instrument within a reasonable space. It is 10 to 20 times as accurate (*i. e.*, gives one more decimal and that more accurately), and where the greater accuracy is important it is not only the best but the only instrument to use. But on the other hand, it is much more than 10 times as bulky and much less handy for use in simple calculations, and hence it does not take the place of the simpler form for such calculation. For example, $5.78 \times 1.21 = 6.9938$. The Mannheim slide rule weighing an ounce or two gives this readily as 6.99. The Thacher instrument will give it as 6.994.—ED. ENG. NEWS.]

Sugar in Mortar.

CHESAPEAKE AND OHIO RY. CO.,
CINCINNATI, Jan. 20, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I see in your issue of Jan. 17 an extract from the *Manufacturer and Builder* about the supposed advantage of mixing sugar with lime for mortar. Any one who has lived in British India, as the writer has, is familiar with the fact that a small quantity of coarse native sugar is always mixed with the cement used in making water-proof floors for bath rooms, etc. I have often wondered Western builders had never "caught on" this idea, remembering, as I do, the hardness and exquisite finish of any bath room in India. Yours truly,

AN ANGLO-INDIAN.

[In our issue of Nov. 20, 1886, page 333, will be found a lengthy reference to authorities treating of the benefits of using *goor*, or the coarse sugar of Bombay, and molasses in mortars. The same subject has been referred to more than once in succeeding issues of this journal, and the late item was only an additional note on an old topic, as our correspondent implies.—ED. ENG. NEWS.]

Wind Pressure Formulas.

WASHINGTON, D. C., Jan. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have been much interested in reading Prof. MARVIN'S paper in your journal for Dec. 13. I can hardly believe that you have fully understood the conditions under which these MARVIN experiments were made. Prof. MARVIN allows 15° slope for the wind up the sides of the mountain, while under most conditions it would be nearer 30° and may be 40°. He assumes certain relations as holding between a pressure of 29.9 ins. and 30.0 ins. at sea level, which certainly should be taken with great caution. Last of all he has absolutely no check on his wind velocity, which he measures with a Robinson anemometer, whose constants up to 30 miles per hour were determined at sea level, but of whose action at higher velocities and on Mount Washington we have almost no means whatever of knowing. Notwithstanding all these chances for error which may easily amount to 20%, you commend this work highly, and ignore the work of THIBAULT, made in exactly the same manner, but with all chances of error eliminated, at least, as relates to errors incident to a pressure of 23.9 ins. and an upward slope of the wind. I do not know how much engineers rely upon computations from such formulæ, but it seems to me there is nothing yet determined more satisfactory than the old $p = .005\ V^2$, and any engineer who uses a smaller constant in computing wind pressures would be reprehensible unless he allowed a good margin for safety. I hope to live to see this question definitely settled and have no doubt myself as to how it will be done, at least for velocities up to 50 miles per hour and surfaces up to 10 ft. square.

H. A. HAZEN.

Formulas for Panel Loads.

LOUISVILLE, Ky., Jan. 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the discussion carried on in your columns about the formula for panel loads, I miss that formula which is simplest, best, and probably oldest.

If $M_n - 1$, M_n, $M_n + 1$ are the moments of all forward loads about the points $n - 1$, n, $n + 1$, and l_n, l, l_{n+1} are the lengths of the panels $n - 1$, n and $n + 1$ then the panel load at n,

$$Rn = \frac{M_n + 1 - M_n}{l_n + 1} - \frac{M_n - M_n - 1}{l_n}$$

This is perfectly general.

If there are no loads forward of $n - 1$, as frequently is the case near the head of the train, $Mn - 1 = 0$ and—

$$Rn = \frac{M_n + 1 - M_n}{l_n + 1} - \frac{M_n}{l_n}$$

If it be desirable to introduce the ratio of the panels the formulas can easily be modified. These formulas are to be used for trestles with unequal panels.

If the panels $ln + 1$ and ln are equal, and equal to l,

$$Rn = \frac{M_n + 1 + M_n - 1 - 2\ M_n}{l}$$

For panel point next to the forward end Mo usually will be zero, and

$$R1 = \frac{M_2 - 2\ M_1}{l}$$

The advantage of these formulas is that any panel load can be found independently of the others. An error in any one is not carried through all the following.

As a point of historical interest it may be well to mention that the principle of the moment table is explained and illustrated by examples in CULMANN, *Graphische Statik*, Zurich, 1875, p. 360, and that to the writer's knowledge moment tables have been in use at least since 1880.

E. E. K.

Random Notes from the Pacific Coast.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: At present more interest is taken by all parts of the Union in Southern California than ever before. There are many reasons for this, not the least being the recent articles by CHARLES DUDLEY WARNER, on the social and climatic status. Then again, most of the larger cities are beginning to recover from the lethargy into which they were thrown by the collapse of the "boom" of several years ago and are sending out less exaggerated accounts of their resources and benefits than was the case in former years.

In Los Angeles, the principal city, and what will one day be the capital of southern California, the first thing which impresses one is the enervating climate, which is particularly noticeable in the late summer and fall, but has its effect throughout the year. Labor, which is paid from 30 to 100% more than in the Central or Eastern states, performs at least 30% less work. That by the time several generations have run their course, the activity of the native residents will have reached the level of their Mexican predecessors, is a conceded matter.

This, with the absence of fuel and material, will limit the establishment of great iron industries, and the engineer must look to the far East or the North coast for the manufacture of his structures.

There is indeed but little demand for engineering talent except land surveyors, of whom there is a surplus, and hydraulic engineers, who are in great and growing demand. In all the fruit regions, where irrigation is the rule, some of the greatest dams in the world have been built, forming mountain reservoirs for the storage of the winter rains, the more important of which have been described in your columns, but there are many of great financial importance which have not been so noticed. At San Fernando, 20 miles north of Los Angeles, there is a submerged dam, quite a curiosity in its way. The river "wash" or 'arroyo" remains perfectly dry during the dry season, but, as is usual in such cases, there is a sub

merged flow of water all the year. To intercept this a trench 600 ft. long, the entire width of the channel, and 50 ft. deep to the rock, was dug and a dam built, rising a few feet above the surface. Along the water face, horizontal rows of tiling were placed, one above the other. The joints in each row were left open about half an inch and wrapped with prepared filtering cloth. The water filtering through was led by these pipes to wells—one at each end and one at the center of the dam, and from these the supply is drawn for the town and for irrigation. For a while the dam worked splendidly, but being only a cemented wall of a few feet thickness, it soon began to leak and recently one half had to be dug out for repairs. Had a competent engineer been employed to determine the proper cross-section and superintend the construction, all this would have been obviated. Examples like this will in time work to the engineer's advantage, but such examples are abundant.

At Hesperia, Cal., the water is carried from the mountains by a ditch down the mountain side; at one place it was necessary to tunnel through solid granite and a spillway was run from this at right-angles out to the face of a cliff, over which the water pours, not less beautiful than a natural fall.

Examples might be multiplied, but it is enough to say that, while such work is dormant now, there is plenty of chance here for the hydraulic engineer of the future.

While Los Angeles is struggling to open an electric street railway, this coast, following the example of its metropolis, San Francisco, is given over to the cable system. The main lines are the Seventh Street, 6 miles in length, and the Grand avenue, 7 miles; the maximum speed specified by law, is eight miles per hour, and on part of one line only six and a fraction is attained.

Compared with the 12 to 16 miles per hour on Chicago roads, this seems slow indeed, but it is in keeping with general tendencies in the vicinity. Part of the Temple street line is single track, and has very heavy grades.

The majority of the paved streets are laid with asphalt, which, with one or two exceptions, are wearing quite smooth. The majority of the sidewalks are of some of the patent cement compositions, and owing to the absence of frost no city in the Union can boast of more superb footways.

Examples may be seen of cement construction which has stood the test of a century—notably in the old missions.

The Sierra Madre range of mountains, some peaks of which carry snow all the year round, relieves any monotony there may be in the landscape, and one soon comes to look each day for the dome of the old observatory on Wilson's Peak, where is soon to be placed the greatest telescope of the world in a new building of the University of Southern California, to be called the "Spence observatory." While this has not been selected as the exact location, it will be somewhere near, on the Sierra Madre range. Calling on Judge R. M. WIDNEY, one of the Regents of the university, it was learned that the crown glass of the 40-in. objective had been successfully cast, and had been received in Boston by the Clarks.

The principal donors were Mr. E. L. SPENCE, who gave $60,000 in real estate, and Mr. DANIEL FREEMAN, $20,000, both gentlemen being residents of the city or county and large land owners.

Only the preliminary calculations have been made for the lens, but it will have greater curvature than the Lick.

No plans have been prepared for the mounting or for the buildings, as it is desired to wait as long as possible—until the lens is complete—that advantage may be taken of the working of the Lick Telescope and any possible improvements made that experience may develop.

The observatory on Wilson's Peak has been in use by Harvard College, where an 8 in photographic lens has been mounted; the atmospheric conditions are good, and a situation on granite bed rock will likely be found here. Mr. CLARK will probably take charge of the instrument for the first three years, to highly perfect its working and efficiency.

"Our Italy" is a very interesting place for the engineer or scientific man to visit, and will have greater attractions each year. Los Angeles is most easily reached by the direct line overland, but for the sight seeing man the more leisurely route is by San Francisco and the Coast Line of Steamers. The *Santa Rosa*, built by the Roach Yards, is the largest boat in this trade. The accommodations are fine and the crew very obliging.

After one hot, dusty ride across the Great Mojave Desert, one does not—unless for fear of seasickness—hesitate long as to the ocean route. Not many months will elapse, it is hoped, before the two short links of the Southern Pacific Coast Line are completed. Then one can, en route, visit the old towns of Monterey, San Luis Obispo, and Santa Barbara. C. E. F.

Notes and Queries.

J. G. T., of Ovid, N. Y., asks: The statement was made to me that the New York Central R. R. operates over 200 miles of track in the city of Buffalo, which, of course, includes sidings and switches. I was referred to you for proof. Will you kindly send me the amount of their trackage or the number of your paper containing the article?

[The statement is correct. In October, 1884 (see Economic Theory of the Location of Railways), the New York Central alone operated 139 miles of track within the city limits of Buffalo. This amount has since been very largely increased, and to somewhat over 200 miles if our memory is correct. We have published the facts within a year or two, but we cannot undertake to make searches through back files in answer to queries like this.]

R. D. R. asks: "Can you tell me who are manufacturers and patentees of the continuous rail joint?"

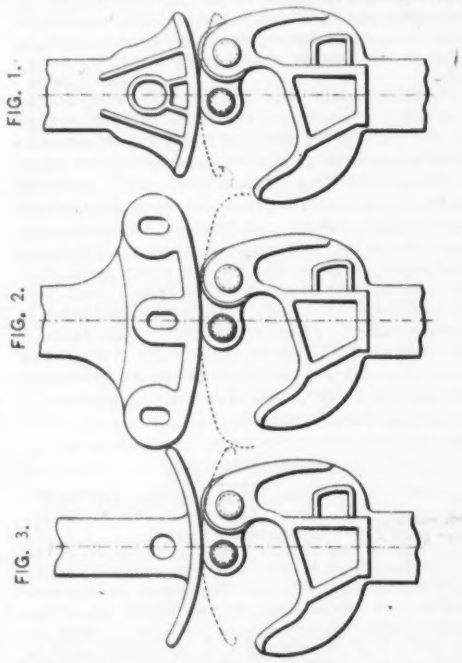
[There are a number of joints manufactured which claim to be "continuous," but we know of none which really are; and which particular one our correspondent refers to we do not know.]

Coupling M. C. B. Couplers with Link and Pin Drawheads.

A correspondent calls attention to what we must admit was an over-broad and over-positive statement in our issue of Jan. 17, made in an editorial note discussing the increased safety to freight trainmen resulting from the use of M. C. B. couplers. We quote it as follows:

The proportion of freight cars now equipped with automatic couplers is too small to show any decrease in injuries and fatalities to trainmen from their use. In fact these have probably been increased, since it is more dangerous to couple the common drawhead to an M. C. B. automatic coupler than to another drawhead using the link.

Our correspondent very justly questions whether it is in fact true that it is more dangerous



to couple the common drawhead to an M. C. B. coupler than to a link drawhead, maintaining that it is in itself less dangerous, and adding further that, whatever may be our belief, or that of any one else on this matter, the statistics of accidents and injuries, which can alone prove the case either way, do not exist, and are practically impossible to secure. In the absence of such statistics, no one, no matter how wide his experience or careful his investigation, is competent to say with certainty that the danger is or is not increased.

In this position our correspondent is manifestly correct. In the existing dearth of statistical record (which is more than likely to always continue), any expression on this point should be opinion only; and we are quite ready to admit that the other view may be the correct one, and that coupling the M. C. B. coupler to a link drawbar may, perhaps, be even safer than coupling two ordinary drawheads with the link. This is the view taken by our correspondent, and in proof thereof he submits the accompanying sketches, showing plans of the M. C. B. coupler meeting various link drawheads.

Fig. 1 is a common type of cast iron drawhead. Fig. 2 is the Potter drawbar, used so extensively on the Western roads. Fig. 3 is a common wrought-iron drawhead. On each view is a dotted outline showing the face of a similar drawbar meeting the one on the left. Our correspondent says, "the idea that the link drawbar comes in contact with the M. C. B. coupler with a glancing blow is erroneous." The two come together in practically as safe a manner upon one side as two link drawbars, and on the other or open side there is so much more room for the hand of the person making the coupling that it is certainly very much safer.

It may be argued that the brakeman making the couplings would never take the trouble to go on the safe side of the train to do it, but even if he does not do this, he is as likely to be on one side of the train as on the other, so that 50% of the couplings will be made on the open or safe side.

It will be seen from the above that there are two sides to the question; and the sketches presented form certainly evidence of considerable weight on the side of the M. C. B. coupler.

Our own view of the matter, which we had in mind in penning the sentence objected to, and might well have amplified more fully to avoid misconstruction, as well as to aid our readers in seeing the truth, is as follows:

As respects the inherent nature of the process, that is to say, the comparative ease with which an unpracticed person would make a coupling or would become expert in it by continual practice, our correspondent's position is beyond all question sound, nor did we have any thought of questioning it in what we wrote. The fallacy of the "glancing blow" theory, as outlined in the drawings, was well known to us. But there is another and a larger factor which enters into the problem.

Coupling cars by hand is a trick of manual dexterity, like a juggler's tricks, or like playing on the piano. With all such tricks the most essential condition of its successful performance is that the performer *shall not think* how he is to do the trick before he does it, but shall perform it almost automatically, as an effect of prior training of the muscles. The pianist who should try to think out at each instant where next he was to place his fingers would never play a tune. It is a physiological fact that the process of thought requires *time*, and not a little of it, and time is just what cannot be spared in all tricks of dexterity.

Therefore, quite apart from the inherent danger of different modes of coupling *under equal conditions*, so long as the transition period to another form endures, every brakeman must first *give thought* to the question of just how he is going to make the next coupling before he makes it, whether it be to couple two "bull-noses" or a bull-nose and an M. C. B., or two M. C. B.'s, and in this stopping to take thought there lurks a real danger of confusion of mind and muscle, which is physiological and not mechanical, and which strongly tends to make what would otherwise be a safer operation temporarily more dangerous. This must happen in changing to any form of coupler, no matter how perfect, for it is an inseparable feature of any period of transition. But whether the loss in this way be greater or less than the undoubted gains which our correspondent points out, is legitimately open to question and doubt. Therefore, we should have so stated it, although our own conviction is that even a bad and dangerous process which is always the same and so is instinctively performed will result in fewer injuries than will an irregular mixture of good and bad during the necessary period of transition. The true moral is to make the period of transition to better things as short as possible; not to prolong it by needless quibbling.

Efficiency of Chimneys.

An old chimney, 67 ft. high, with internal diameter of 19.6 ins. to 13.8 ins., and with total passage from fire to chimney-top of 98 ft., was taken down, and a new chimney with an internal total height of 95 ft. and a minimum internal diameter of 25.5 ins. was planned out. When the chimney had gone up 39 ft. it was tried. Already there was a great improvement on the old chimney; again at 46 ft. it was much better, and at 52½ ft. the draught was excellent, the smoke issued clean, without soot, and there was an economy of from 15% to 20% in fuel. So the chimney was finished off at that height. Herr HUTH thinks that chimneys are usually made too narrow, and the mischief is aggravated by increasing their height, so that fuel escapes unburned. Herr RAMDOHR, of Gotha, confirms this, and recommends a uniform internal diameter as being more rational, and as protecting the brickwork from the hot and rapid axial stream,

The cross-section of the chimney should be from one-fourth to one-eighth the grate area, and the height not less than 50 ft., should not exceed 100 to 120 ft. (the diameter being made to suit), unless the chimney is at a distance, in which case it may be 160 to 200 ft., the diameter being regulated according to the amount of soot which escapes. —*The Brickmaker.*

Regulations Concerning the Pollution of Streams in New Jersey.*

At the last session of the Association the undersigned were appointed a committee to submit a standard or standards of purity for matter from purification works entering streams in this State. The aim of the resolution was apparently to protect the streams of the State from pollution, while furnishing some practicable basis for the design and maintenance of sewage purification works.

It is perhaps unfortunate that the phraseology of the resolution was not more comprehensive, but its intention is not so manifest, that we felt called upon to make our report, upon the broader subject of stream pollution.

We recognize that consideration of the subject is timely and urgent. We realize, however, that its proper presentation involves consideration of complex questions, which have proved most embarrassing wherever their solution has been essayed. There is to-day no law in this State, which deals effectively with the evils of pollution in potable streams. The text of the law is as follows:

"*An Act to Prevent the Willful Pollution of Water of any of the Creeks, Ponds, or Brooks of the State.*

"That if any person or persons shall throw, cause or permit to be thrown into the waters of any creek, pond or brooks of this State the waters of which are used to supply any aqueduct or reservoir for distribution or public use any carcass of any dead animal or any offal or offensive matter whatsoever, calculated to render such waters impure or to create noxious or offensive smells, or shall connect any water closet with any sewer or other means whereby the contents thereof may be conveyed to and into any such creek pond or brook, such person or persons shall be deemed guilty of a misdemeanor and on conviction thereof shall be punished by a fine not exceeding $1,000, or by imprisonment not exceeding two years, or both." (Approved, April 21, 1876.)

The text of the law is open to various constructions, and its letter and spirit are constantly violated. Official classification of the streams of the State has never been attempted. The abilities of the various streams to digest or absorb varying volumes of different impurities has never been ascertained, or the determination attempted.

Obviously a certain volume of liquid more or less polluted, which would be permissible of discharge in the lower Passaic, *e. g.*, at Paterson, would be intolerable in the Hackensack above New Milford, or the east branch of the Rahway above Sodom, and yet some competent authority should decide what these limits are and prevent their violation. Yet it does not seem reasonable to require that all polluting matters shall be excluded from all streams, not reasonable because neither practicable, nor possible. The purifying powers of streams through the processes of subsidence, dilution, oxidation and nitrification are recognized, but the relative activity of the different processes is not determined. Are these matters fairly left to the courts to decide? If so, the unfortunate sufferer, who is lacking either the means or the inclination to secure relief, through tedious litigation, must continue to suffer.

It appears to your committee wiser to clothe some competent board with the power to investigate thoroughly the entire subject; to determine what is necessary and possible under the conditions existing in each locality and to enforce such conditions.

In 1875 the State Board of Health of Massachusetts, acting under authority of the State Legislature, investigated with great thoroughness "the methods of sewerage and drainage of cities and towns of the Commonwealth, especially with regard to the pollution of rivers, estuaries and ponds, by such drainage or sewerage," and was instructed "to devise and report a system or method by which said cities and towns may be properly drained and said rivers, estuaries and ponds may be protected against pollution, so far as possible, with the view of the preservation of the health of the inhabitants and the securing to the several cities and towns thereof, a proper system of sewerage, and drainage, without injury to the rights and health of others; also to report how far said sewage may be utilized and disposed of."

The report of the State Board under this authority stands as a monument of intelligent research and vigorous recommendation. It was the beginning of all that has been done in Massachusetts for the preservation of the smaller streams from pollution.

The law of Massachusetts now provides that the State Board of Health "shall have the general supervision of all streams and ponds used by a city or town as sources of water supply, with reference to their purity, together with all springs, streams and water courses, tributary thereto; and shall have authority to examine the same from time to time and inquire what pollutions exist and what are their causes and upon complaint to any municipal authority of pollution of a water course, the Board shall give a public hearing of the case and if in its judgement, the public health requires, it may prohibit such pollution.

The River Pollution Commission in England attempted in 1886 to fix rigid chemical standards for liquids entering streams of the various classes, but in the operation of the law consideration is given the local conditions. Were a fixed standard to be attempted at the present time biological considerations would doubtless enter into it.

In a memorial on the pollution of streams, prepared by Dr. KONRAD WILHELM JURISH, of the Royal Technical School of Berlin, for the river commission of the society for the preservation of the interests of the chemical industries of Germany, just published in Berlin, conclusions similar to those here submitted are reached. The inquiry has been pursued with the care for which German investigators are famous, and the recommendations appear as the logical result of the facts collected. The conclusions are as follows:

"A general treatment of waste waters entering streams must be considered as an impossibility. The nature and quality of the waste water, the volume of the streams, current, situation of factories, condition of the river bed, the previous use of the water in the stream and many other conditions, must be determined for each case, and for each case a solution must be given.

"The disposal of factory wastes in the streams is necessary and justifiable. The rivers are to be considered and used as the natural drains for waste waters, and in each particular case the conditions are to be tested and ascertained; particular attention must be paid to the effect of the volume of water in rivers and brooks in rendering the wastes innocuous through:

"(1) Dilution.

"(2) Chemical action.

"(3) Vegetable and animal life processes.

"The determination of the general limits to the amounts of injurious constituents contained in waste waters at the point of discharge into the river cannot be made, because such limits are influenced by the particular conditions in each case.

"Manufacturers generally recognize it as a fundamental duty to avoid or to lessen so far as possible by means of the agents offered by science and practice the evils arising from waste waters. At the same time, however, in case of a conflict of interests which cannot be harmonized the one of greater general importance should be protected.

"In order to treat uniformly and justly such conflicts of interest the creation of a municipal technical commission would seem to be advisable."

It does not appear practicable to your Committee to erect any arbitrary standard of purity for liquids entering various streams. Fluid impurities emanating from manufactories and from sewer outfalls are so heterogeneous, that rigid standards can hardly embrace all that is deleterious, without working a hardship to some localities where the pollution is harmless.

We believe that an intelligent and comprehensive classification of the streams of the State, to be periodically revised, should be made with due regard to the purifying energy of each, and that clearly defined control of pollution should be vested in some competent body, whose province should be to summarily prevent harmful pollution and sanction the discharge of such liquids as in the particular case in question were permissible and safe. Such classification should discriminate between potable streams and their tributaries, non-potable fresh water streams, streams subject to tidal influence and estuaries.

Concerning the specific question of effluents from sewage purification works, we have to say that in certain localities in the State some purification of the sewage is an essential of a sewerage system; the towns with this difficulty before them, under existing conditions, hesitate to undertake the work of sewerage, because they do not know that an effluent from disposal works can be secured, which will be allowed to flow into adjacent streams. Processes of sewage purification are available, which can give the necessary purity for any of these localities, and yet in the absence of any authority to which the towns can apply for official approval of their plans, they hesitate to abandon leaching vaults and reeking cesspools in the midst of dense populations.

Where purification works have been erected they have been allowed by their managers to discharge indifferent to impure effluents; or opponents of them have insisted that they should discharge only water of a purity which is in reality superfluous or impracticable. These difficulties would be lessened, if not abolished, if there existed some board with recognized authority in such matters, whose surveillance should be required and whose decision should be final.

In consideration of the facts hereinbefore stated, we respectfully submit the following: We recommend the passage of an act empowering the State Board of Health to act as arbiters in all matters affecting the pollution of streams, water courses and lakes; and further, that this association pass a resolution requesting the State Board of Health to co-operate in securing the passage of such an act, with provisions for its practical enforcement.

* A report presented to the New Jersey Sanitary Commission, December, 1890, by CARROL PH. BASSETT, M. Am. Soc. C. E., Chairman of a committee, consisting, in addition, of PETER T. AUSTIN, CHARLES B. BRUSH, M. Am. Soc. C. E., JAMES OWEN, Mem. Am. Soc. C. E., and W. K. NEWTON.

Hours of Labor of Railway Employees in England.

Among the Parliamentary papers recently issued is one entitled, "Return in pursuance of Section 4, of the Regulation of Railways Act, 1889, of certain classes of weekly paid servants who were, during the months of September, 1889, and March, 1890, on duty on the railways of the United Kingdom for more than 12 hours at a time; or who, after being on duty more than 12 hours, were allowed to resume work with less than eight hours' rest." This return gives in tabular form for each railway the number of employees, the number and percentage on duty more than 12 hours at a time, the number and percentage of instances of such duty for one to six hours; also the number and percentage of instances of duty having been resumed after from one to seven hours' rest. The figures are given for the two months mentioned above, and include the following classes of employees: Passenger guards, goods guards, engine drivers and firemen, signalmen and examiners. No totals or averages are given for all the roads together. From this report we have selected 17 of the principal English roads, five of the Scotch, and three of the Irish roads, and have compiled the following table giving the total number of engine drivers and firemen and signalmen, and the number who were on duty for more than 12 hours at a time during the month of March, 1890:

Railways.	Engine drivers and firemen.			Signalmen.		
	Total number.	Number on duty over 12 hours.	Percentage.	Total number.	Number on duty over 12 hours.	Percentage.
England.						
Cheshire Lines	321	137	42.67	217	7	3.23
Great Eastern	1,620	1,128	69.63	1,019	57	5.59
Great Northern	1,533	1,332	86.88	1,058	105	9.92
Great Western	3,114	2,608	81.75	2,151	132	6.13
Lancashire & Y'rk shire	1,636	1,617	98.83	1,271	238	18.72
London & North-western	5,652	4,813	85.15	2,293	92	4.01
London & South-western	1,015	(nil)	(nil)	874	(nil)	(nil)
London, Brighton & South Coast	751	685	91.21	592	1	0.16
London, Chatham & Dover	368	311	84.51	269	16	5.94
Manchester, Sheff'ld & Linc'nsh'e	945	644	68.15	709	115	16.22
Metropolitan	186	30	16.00	121	(nil)	(nil)
Metropolitan Dist.	145	14	9.66	89	(nil)	(nil)
*Midland	3,930	3,705	94.27	2,044	A { 1680 / 129	A 82.19 / 6.31
Northeastern	2,903	2,370	81.92	1,897	163	8.59
North London	207	46	22.22	145	52	35.86
Southeastern	707	675	95.47	566	37	6.53
Taff Vale	427	361	84.54	304	57	18.75
	25,450	20,476	80.46	15,619	2,881	18.45
Scotland.						
Caledonian	1,426	1,216	85.27	850	5	0.58
Glasgow & South-western	578	518	89.61	385	13	3.37
Great North of Scotland	143	54	37.76	62	(nil)	(nil)
Highland	120	(nil)	(nil)	117	(nil)	(nil)
North British	1,563	1,121	70.37	1,028	61	5.93
	3,860	2,909	75.36	2,442	79	3.23
Ireland.						
Great Northern	208	94	45.19	115	2	1.74
Great Southern & Western	242	150	61.99	.....	.....	.....
†Midland Great Western	158	118	74.6	81	.....	.....
	608	362	59.54	196	2	1.02

* This return excludes fractions of an hour, and intervals of rest when the men have been off duty, but includes meal hours. The instances marked A arise solely from the fact that the signalmen prefer to work 13 or 14 hours on night duty, and 10 or 11 hours only on day duty.

† In all cases one hour before starting and one hour after arrival of trains have been added to the actual running time of every driver and fireman referred to in this return.

The English roads include three of the city and suburban lines of London, which have a heavy passenger traffic, viz., the Metropolitan, Metropolitan District and North London roads. Our figures show that on these 17 roads, 80.46% of the enginemen and 18.45% of the signalmen were on duty for more than 12 hours; the percentages range from 16 to 98.83% for the former, and from 0.16 to 82.19% for the latter. Few of the principal roads report that none of their

men work more than 12 hours at a time. The percentages of the guards or conductors who work over 12 hours on the same roads ra ge as follows: Passenger guards, from 0.66 to 33.33%; goods guards, from 11 to 96.79%. These figures will probably be a surprise to persons in England who are not familiar with the railway service, and they are of interest here as showing the amount of work required of English railway employees. While there may be cases, as on branch lines with light traffic, where such a length of service may not be very much of a hardship to the men, or likely to result in accidents, yet the statement that on the most important lines, and those employing the greatest number of men, such a large number of the employees are on duty for more than 12 hours, points to a very probable source of danger, and to one of the causes of the recent labor troubles. The statement certainly does not make a showing creditable to the railway companies.

Those who wish to examine the Government return in detail, can obtain it from Messrs. Eyre & Spottiswood, London. The price is 11 cts., or about 15 cts. including postage. It can be ordered through this journal.

Centrifugal Pumps,

At a recent meeting of the Technical Society of the Pacific Coast a paper on "Balancing Centrifugal Pumps" was read by Mr. JOHN RICHARDS, President of the society. The author began his paper with a brief history of the centrifugal pump, which we abstract as follows:

The centrifugal pump is an American invention, and was in use as early as 1818, or 30 years before any pumps of the type were made in Europe. In 1830 these pumps, which were then made with four straight vanes, wers exhibited in New York City under the name of "Massachusetts pumps."

In 1839 Mr. ANDREWS, of New York, added the spiral casing to the pump, which considerably increased its efficiency at high heads. At about the same time Mr. JAS. STUART GWYNNE, an Englishman residing in the United States, became interested in the "Massachusetts pump," and set about improving its design. After a few years he went to England and began the manufacture of centrifugal pumps there. Among his competitors was APPOLD, who has been credited with the invention of

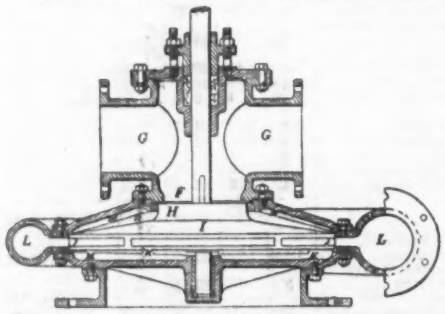


Fig. 1. Vertical Section of Centrifugal Pit Pump.

the centrifugal pump. APPOLD'S designs were taken up and put into successful practice by the London firm of EASTON & ANDERSON. Sir HENRY BESSEMER was also at one time interested in the centrifugal pump in connection with the design of sugar-house machinery, and he patented several designs. In the Bessemer pumps the tangential energy of the water leaving the vanes was ignored, and at low heads the pumps never had much efficiency.

The author then took up the subject of balancing centrifugal pumps. An unbalanced pump will quickly burn out its bearings, because the pressure exceeds the limit allowable for bearing metals. Fig. 1 is a vertical section of a pit pump, as it is called in California, designed by the author in 1886. The water enters by double inlets *G*, at the top of the pump, passes through the nozzle *H* to the interior of the wheel *I*, and is discharged at the periphery *J* into the casing *L* against a pressure due to the head. If the head is 60 ft., then the pressure at *J J* and also in the spaces *D* and *E*, above and below the wheel, is 60 × .43 = 25.8 lbs. per sq. in. hydrostatic pressure, which would be increased to about 30 lbs. per sq. in. when the wheel is working.

Suppose the wheel *I* to be 30 ins. in diameter, then the area of one side = 706.8 sq. ins., and the pressure on this area at the above head will be 706.8 × 30 = 21,204 lbs. But, while this is the pressure on the lower side, that on the upper side is decreased by the area of the inlet *F*. This diameter is commonly made one-third the diameter of the wheel, which in this case would make it 10 ins. So the pressure on the bottom of the wheel exceeds that on the top by the pressure on an equal area on the bottom side, = 78.5 sq. ins. This repesents an upthrust of 2,355 lbs., which is enough to sustain the wheel with a shaft 2½ ins. diameter and 60 ft. long, with its couplings, pulleys, etc. In balancing centrifugal pumps the end desired is to so control this thrust at different heads as to balance the weight of the wheel and connections without altering the area of the inlet *F*.

It will be noticed that in the foregoing explanation no account has been taken of the rotation of the water and consequent centrifugal effect in the spaces *E* and *D*. It is evident that if rotation is set up in the spaces *E* and *D*, whatever centrifugal force results tends to balance the pressure at *J*; hence the amount of upthrust due to the inlet at *F* can be regulated by the amount of rotation under the wheel at *E*. This is the method which the author has adopted in these pumps, applying shallow vanes *K* on the bottom of the wheel, of varied length and depth to suit the heads under which the pumps are to operate.

This method of balancing is a very sensitive one. In a case in mind one inch cut from the tips of the

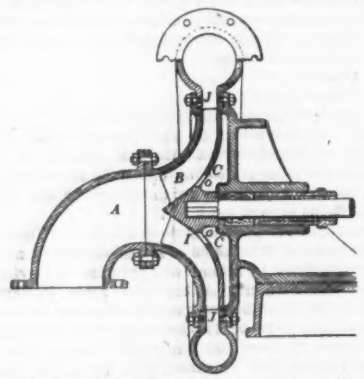


Fig. 2. Section of Centrifugal Pump with Horizontal Shaft.

vanes *K*, which were only ⅝ in. square, made a difference of more than 300 lbs. in the thrust on the shaft. If the space *E* is much widened by the raising of the wheel, then the effect of the vanes *K* is less, and the upward thrust is cumulative, increasing as the wheel rises. This is a feature only recently discovered by the author.

One other feature with regard to encased wheels deserves attention. The joint around the nipple *H* should be maintained water-tight. Any water forced back around this nipple will re-enter at the inlet *F*, and merely circulate in the pump. This is an objection to encased wheels, and should prevent them from being used for pumping water containing grit or sand.

Fig. 2 shows another design by the author, which is claimed to give a close approximation to the maximum theoretical efficiency. The inlet *A*, is at the side so as to be easy to remove. The main casing *T* is volute in form and so constructed as to be set in any position on the frame. The course of the water, from *A* through *B* to *J* is kept as nearly uniform as possible. The packing around the spindle is placed inside the main bearing, and there is, by reason of the concave form, but little overhang of the wheel.

Consider now the pressures. The wheel is a disk with vanes *B* and *I* on its front side. Suppose this disk to be 30 ins. in diameter and made solid. Then under a head of 40 ft. and pressure per sq. in. of 19 lbs. the total lateral pressure would be, 706.8 ins. (area) × 19 = 13,429 lbs. As constructed, however, the wheel has deep vanes *I*, *B*, on the front and shallow vanes *C*, *C*, on the back, with orifices *O*, *O*, admitting water to the back. It is evident that centrifugal action is the same or nearly the same on each side of the wheel; but all the water passes on the front of the wheel. The rear or balancing vanes are ⅝ to ¾ ins. shorter than the front vanes, as shown in the drawing. This slight difference causes the centrifugal force on the front to overbalance that on the rear of the disk, and there is a slow circulation of water over the periphery and through the holes *O*, *O*, from the back of the disk to the front. The author maintains that a pump thus balanced is as nearly in equilibrium as one with a forked or double inlet, and is more likely to remain balanced because there is less liability of obstruction, the waterways being more direct.

Thus it will be seen that the working conditions of a pump are changed by the kind of wheel employed. If the wheel is encased, the whole interior of the pump sustains the discharge pressure. With an open wheel there is no pressure at the center, and only one-half as much on the sides of the casing. The friction, however, is the same in both cases. With the inclosed wheels the friction is between the wheel and the water. With an open wheel the friction is between the water and the main casing

Fig. 3. Open Wheel for Centrifugal Dredging Pump.

at the sides. Except for use in pits, etc., where thrust is desirable to balance the weight of the driving shaft, the author believes that open wheels or wheels with vanes on each side of the central disk are preferable.

Fig. 3 shows an open wheel for a dredging pump recently designed for the San Francisco Bridge Co. A similar pump has been built for dredging in the harbor at Boston, Mass. These wheels are of steel. There is no chance of obstruction and in dredging there is no disintegration of the material beyond reducing it to the size of the discharge pipes. The author has seen these pumps lifting more than 50% of solid matter. Dredging pumps should always be made with open wheels and with a single suction, to give as large a waterway as possible. The lateral thrust on a wheel like Fig. 3 is equal to the area of the cross section of its shaft multiplied by the pressure per unit of area due to the head, which is just about enough to keep the wheel in alignment if its bearings should wear.

In answer to questions, the author said that the highest recorded efficiency of centrifugal pumps had been obtained at Ferrara, Italy, where a very large plant is working showing an efficiency of 67%. The efficiency of a well made pump should not be less than 60%; but such pumps as are in the market will not average over 40%. For ordinary heads the centrifugal pump is the most efficient in use. The highest heads in use in America are 95 to 100 ft. M. FARCOT, of Paris, says his pumps work under a head of 30 meters (98.4 ft.). When the head is more than 60 ft. the efficiency seems to remain practically constant.

Mr. WAGONER gave his formula for the speed of centrifugal pumps. The proper velocity in feet per second at the end of the vanes is 10 $\sqrt{\text{head}}$ for the ordinary form of vanes. Experiments at the University of California have shown that the skin friction of a disk revolving in water varies as the fifth power of the diameter and the cube of the speed. Now, with the high velocities required for heads of 100 to 300 ft. the skin friction must increase so rapidly that the efficiency must be lowered. Centrifugal pumps have been operated at very high heads but he did not know with what efficiency.

Mr. A. B. BOWERS said that he built his dredging pumps with a double inlet. The difficulty with pumps having an inlet on only one side and balanced, as Mr. RICHARDS proposed, is that they are fully balanced only when working against the heads for which they have been specially designed. An involute is clearly the best curve for the inner ends of the vanes. The first pumps built by Mr. BOWERS had inlets one-third the diameter of the runner; from later experience he had made the inlets somewhat larger. These pumps are used for handling sand, gravel, clay and dock mud. This work cuts out the casing of the pumps very fast. When the

pumps have handled 500,000 cu. yds. of sharp sand they are completely worn out. APPOLD is said to have experimented with vanes radial, inclined (at 45°), and curved, with results showing efficiency in the order named. German designers have tried making the vanes run further back than the Appold, extending through an angle (measured between radial lines) of about 120°, but the pump had to be driven very rapidly, and even then the efficiency was low. Some pumps at the Berlin Exposition are said to have given an efficiency of 82%, but the correctness of the test is doubted. A great many centrifugal pumps in the market show an efficiency of less than 20%, and 50% is about as high as can be calculated on with the best. Mr. BOWERS thinks however, that he is getting over 60% with his pumps. These have discharged sharp sand at an elevation of 10 to 20 ft., according to tide, and through 3,600 ft. of pipe. They have delivered 5,000 cu. yds. of sand per day in regular work. On one occasion in 23 hours the delivery was a little under 9,000 yds. Points in the design of centrifugal pumps which need further and careful testing are the ratios between the size of the inlet and the runner, the best width and best angle of the vanes. A pump made by Mr. BOWERS, working on a dredging machine at Tacoma, Wash., has a runner 6 ft. in diameter, with 6 recurved vanes, inner breadth of vanes 17 ins., outer breadth 6 ins. The pump makes 160 to 185 revolutions per minute and uses from 160 to 190 HP. The suction pipe is 20 ins. and discharge pipe 18 ins. inside diameter. This pump has discharged 20,000 galls. clear water per minute at an elevation of 10 ft. [showing an efficiency probably of 40 % or more]. Sometimes when carrying a large percentage of sand the discharge is not more than half as much.

The Ten-Block System for Numbering Country Houses.

Mr. A. L. BANCROFT, of Ignacio Valley, Contra Costa Co., Cal., has originated a system for numbering and exactly locating country houses. The scheme was first published in the *Contra Costa Gazette*, but it is made plainer in a review of the work of a committee appointed to investigate the plan, published in the *Providence Journal*. We republish this as follows:

An imaginary line is drawn due north and south through the county seat, and the roads are named in order, from left to right, the process beginning at the left of the imaginary line and continuing in a circle to the east, south, west and again to the north. Those roads are first listed which touch the county seat, next the first left-hand branch roads and any left-hand branches of these, then the right-hand branches and the remaining trunk roads and their branches, left-hand branches first, right-hand branches next, nothing on the left being omitted until the entire circuit has been made and the roads of the county are all named. As for the names themselves, the Contra Costa committee recommends that titles "appropriate, significant and pleasing to the eye and ear" be selected, first with regard to the landscape and other features of the locality. Where names of this sort fail, other classes may be drawn upon for designations. Thus the name of Contra Costa Highway has been given to the chief country road, and the term highway has been reserved for it alone; "Alhambra way" extends through the Alhambra Valley; "Franklin road" leads through Franklin cañon; "Rio Vista" extends along a bluff which overlooks a river, and "Golden Gateway" ends on a summit from which the Golden Gate itself may be seen. Names to be avoided, says the committee, are those of residents, which might not be satisfactory to all; those with possessives, and the designations of towns as, for example, "Pacheco road," to indicate the road from Martinez to Pacheco, when from Pacheco to Martinez it would naturally be "Martinez road," and beyond Pacheco toward Walnut Creek the "Walnut Creek road." It has been the purpose of the committee to make the same name do for stretches as long as possible, and so comprehensive names have been found necessary.

Three special name words have been adopted to aid in designating roads, "Local," "Connex" and "Exit," each of which has a definite and uniform meaning. A local is a road without an outlet, and a stranger at its entrance learns from the name on the guideboard that there is no way of egress except where he stands; a connex is a short road without branches, useful chiefly in connecting more important roads, and an exit is a road having no outlet by land, but simply a water exit, ending usually at a landing where vessels receive and discharge cargoes. Such names as alley, passage, court, place, row, street, promenade and avenue are avoided, as belonging distinctively to towns and villages. And it may be known at once whether a person whose formal address is given lives in the country or in the town.

Another, and perhaps the most interesting feature of the whole plan, is that known as the ten-block system, already developed and apparently satisfactory for most communities whether the other provisions of the scheme are adopted or not. The roads having been named are measured and each mile is divided into 10 equal parts or imaginary blocks with a frontage on the road of 528 ft. Two numbers are alloted to each block, the odd ones on the left and the even ones on the right, each house located within a given block having the number of that block. It is infrequently the case that country houses are nearer than a tenth of a mile, but in such an event those standing within the same block all have the same number, followed by the letters of the alphabet in order, as 236, 236 *a*, 236 *b*, 236 *c*, etc. By this system the distance of any house from the beginning of the road or from another house can be determined easily.

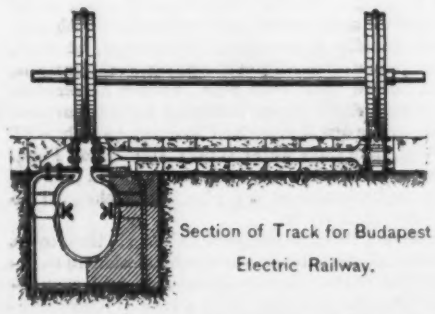
The merits of the system are obvious, while certain features may not appear practical or desirable. Certainly the essential result of its adoption is good, to furnish a more uniform and appropriate nomenclature, and with the ten-block system a better guide to country residents than exists at present. There are difficulties in the way, as there are in every plan, such as in coming to an agreement concerning names, determining where town ends and country begins, and extending and limiting the new nomenclature to correspond with artificial boundaries.

There is, says the *Journal*, a special difficulty in the New England States, where the county is not a compact organization like the township, and where there are sometimes more than one county seat through which to draw the Contra Costa imaginary line. It might be well for townships to adopt the scheme, but even then a difficulty would be encountered, when a well-known road extending through two or three townships became burdened with a name for each. Suppose, again, that the county seat is a populous town and that the roads of the county are to be named and numbered from it as a center. Just where in the town is the naming and numbering to begin? If not at some one central point, then in the suburbs, presumably, but where? At some arbitrary point? Yet as the town increases naturally at a considerable rate as compared with that of the country districts, and often rapidly, will the suburban residents whose houses have been numbered by the ten-block system, and who are now practically within the town or city, submit to a continuance of the rural plan, and if they become dissatisfied and a change is effected, will not the entire system, so far as that road is concerned, be upset? These people naturally will desire to affiliate with the center of population and associate themselves with urban nomenclature.

Yet, on the whole, the Contra Costa plan seems feasible and desirable. It may not be suited to general adoption as it stands, but it is in the right direction and in its essential features provides for a growing country need.

Track for Electric Railway in Budapest.

The electric railways in Budapest have proved remarkably satisfactory in practice, and the contractors, Siemens & Halske, have demonstrated that it is practicable to operate a street railway by the conduit electric system. Since this plan, when successful, presents many advantages over the overhead



Section of Track for Budapest Electric Railway.

trolley, we reproduce from the *Wochenschrift des Oesterr. Ingenieur-Vereines*, the accompanying section of the track.

The great difficulty with underground conduits lies in the fact that the wires contained within them are occasionally short-circuited by water entering the slot rails. Apparently this difficulty has not been experienced in Budapest. The track in that city is formed of one Haarmann rail and one slot rail. Under the latter is the concrete conduit, 11.2 ins. wide and 13.2 ins. high. Iron yokes are placed under this rail every 3.9 ft. The conductors consist of two small angle irons, one on each wall of the conduit and at such a height that they are out of the way of water and dirt. The slot is 1.3 ins. wide and acts as a guide to the wheels on one side of the car as well as an entrance for the trolley rods. The lines include nearly 5.15 miles of both single and double track, and have been operated more than a year. The rolling stock consists of 50 motor and 8 trailing cars, which differ in few respects from those built in this country.

Creosote as a Preservative of Timber.

The dead oil of common coal tar contains, says Dr. LETHABY, all the elements which are necessary for giving permanent stability to organic compounds, by checking decomposition, by opposing the processes of oxidation and by destroying the vitality of the lower forms of animal and vegetable life. If, indeed, the application of creosote to timber has ever failed in preventing decay, it has been because of the improper use of it, or the use of an oil which has not contained a due proportion of its most effective constituent—carbolic acid. This it is which is chiefly concerned in strengthening the weak affinities of the young or immature constituents of wood. It coagulates the albumen, and gives firmness to the cellulose matters that are so prone to decay, and which communicate by a sort of catalyptic influence their decomposition to the neighboring and more mature tissues. So powerful is the antiseptic property of this acid, that when separated from coal tar it will at once arrest the decomposition of every kind of organic matter. It stops the putrefactive changes of sewage and cesspool matter instantly, and it will even stay the more active decomposition of putrefying animal flesh. It is to be regretted that all samples of dead oil do not contain a like proportion of this valuable constituent. It ranges from 0.50% to rather more than 6% of the oil; and as the value of the oil is dependent on the proportion of this acid, it is a matter of some importance to know how its presence can be discovered. A rough estimate may easily be made by shaking up about half a pint of dead oil with its own bulk of a rather weak solution of caustic potash. After standing for a little while the oil will separate, and the potash solution of the carbolic acid may be poured off. On acidulating this with sulphuric acid, the carbolic acid will separate like an oil, and it may be known by its creosote-like odor.

Another important constituent of dead oil is the hydrocarbon, which gradually discolors the oil and thickens it by absorbing atmospheric oxygen and forming a solid pitch. This operates in preserving wood by appropriating the oxygen which may be within its pores, and so checking ligneous eremacausis. The resinoid body which is formed shuts up the pores of the wood and effectually protects it from the action of air and moisture. The presence of this hydrocarbon may be known by the darkening and, as it were, drying of the oil, when it is put upon white filter paper and exposed to the air. In the distillation of the oil this compound comes over most freely at the time when the naphthaline distils, at from 360° to 490° F. The carbolic acid is most abundant in the runnings at or near to the first temperature, and the media for holding them in solution or applying them to the timber at the last. Naphthaline and paranaphthaline, or salts, as they are sometimes termed, will of course come over at these temperatures; but as these substances are of no value whatever in preserving timber, they should be separated as far as possible by submitting the oil to cold and to the action of time. Dead oil should not be exposed to the air more than is necessary, in order that oxygen may not be absorbed and the oil thickened and discolored. Lastly, it may be said that carbolic acid and the hydrocarbons of dead oil are among the most powerful poisons to fungi and acori, and all the lower forms of organic life. The oil, therefore, acts as a physiological preservative of timber. In point of fact its preservative action is of four kinds:

1. It coagulates albuminous substances, and gives stability to the constituents of the cambium and cellulose of the young wood.

2. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissue.

3. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.

4. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acori, and other parasites.

No doubt the action of the oil is injurious to higher forms of animal life. It is even offensive to people, and hence the objection to its use in the interior of buildings. But this objection may be overcome by the use of agents which, like nitric acid in its action on the benzole of the lighter oil of coal tar, may give to the dead oil a less offensive, if not a positively pleasant odor. When this is accomplished there can be no objection to its use in the interior of buildings, or for the preservation of ships.—*The Architect* (London).

Coffer Dam and Concrete Mixer at Mare Island Dry Dock, California.

The transactions of the Technical Society of the Pacific Coast, for March, 1890, contain a paper by Mr. OTTO V. GELDERN, C. E., on the dry dock and coffer dam at the Mare Island Navy Yard, California. We omit the history of this government work, commenced in 1872, and the parts relating only to the stone and concrete dry dock itself, and select the parts relating to the building of the coffer dam and concrete mixing as being of the greatest general interest.

The site of the dock was favorable, as hard bottom was found 35 ft. below the highest tide, covered by a deposit of soft mud from 15 to 20 ft. deep. The excavation extended to a depth of 40 ft. below this high tide plane, the bottom showing a stiff bluish and yellow marly clay. Water was not present in this clay to any great extent.

The coffer-dam was designed by Mr. CALVIN BROWN, C. E., then chief constructing engineer of the navy yard. The front face of the dam, was 240 ft. long, with wings running at right angles to the front, and shoreward, for about 100 ft. Beyond these wings a double row of lighter piling extended 100 ft. further to firm ground as shown in the plans. The main dam consisted of three rows of 15 × 15-in. sheet piling, 16 ft. apart in the rows, and the piles closely driven. Waling pieces, 12 × 12 ins., were used for connection and located 1 ft. and 10 ft. below the top of the dam, the piles being cut off uniformly at a considerable height above the highest water. The three rows of piles in the front, and the two rows in the sides, were tied together by 2-in. iron rods at intervals of 10 ft. and through the upper and lower waling pieces. To add to the stability of the front of the dam, four buttresses were used, each made of 24 15 × 15-in. piles, driven at right angles to the inner row of the face. These buttress walls were braced by heavy timbers laterally and tied to the three rows by a long cap running over the heads of the piles. Similar buttresses were added to the wings, three on the north and five on the south side.

When the pile driving was sufficiently advanced, puddling between the rows was commenced; and for this purpose the stiff material taken from the dock pit was used, and tamped by rammers. This clay packed well and forced out the soft material through an opening left for that purpose at the end of the front row of piles. The first pile was driven Sept. 17, 1872, and the dam was closed and pumped out in October, 1873. But after the water had been lowered to a point 2 ft. 6 ins, below average low tide, or 8 ft. in all, the dam gave way at the junction of the north wing and front. This point was then strengthened by additional braces, by running continuous timbers from wing to wing locked in at the end of each buttress, and by heavy iron straps at the corners. After the puddling had been renewed the water was kept down to 2 ft. 6 ins. level for some days, and the whole dam then pumped out. The dam never gave any trouble after that; it bulged in slightly, but a small pump operated at intervals kept out all the water. The dam stood for 12 or 13 years. The estimated cost of the dam was $93,000; but its actual cost is unknown.

The piles were driven with blunt ends and by an ordinary driver on a scow, with a 1¼-ton hammer. Unsuccessful and costly experiments were made with the once famous gunpowder pile driver. To keep the top of the piles from brooming an iron ring was used. The pile was driven until the penetration from blow was about ¼ in., when the top was cut off to a line. The deepest driving into hard clay was 20 ft.

As the dry dock was practically built of concrete, with stone steps, the mixing of the concrete material was an important feature of the work. The composition of this concrete was: broken stone (egg-size), 50%; gravel, 42%, and sand, 8%. The volume of the mixture was about two-thirds of the total volume of ingredients, and after tamping the mass was reduced to about five-eighths.

For the rapid manufacture of the concrete Mr. BROWN used a modified French concrete mixer, made up of a series of chutes, as illustrated in the cut given herewith. As there shown the upper platform was about on a level with the surface of the ground and the concrete was delivered near the bottom level. The top hoppers are closed with hinged trap doors, operated by levers. In the vertical chute, which is about 2 ft. square, six curved plates are attached to the sides at an angle of 45°, with all exposed surfaces protected by sheet iron. The cement and gravel were placed in the hopper over the vertical chute, and this was then moistened sufficiently from the water tank placed above it; the adjoining hopper for broken stone was also filled and, at a given signal, both charges were released and joined together in the "collector" hopper. A man stationed at this last hopper inspected it and if too dry more water was added before the mixture was allowed to decend to the outlet below. This lower chute contained four flat catch boards, similar to those before described, which thoroughly incorporated the mortar and broken stone.

When the mass was finally discharged on the bottom platform it was "pretty good concrete, ready for use." This mixer made a batch of half a cubic yard of concrete at a time; and the practical proportions used for each batch were—6 wheelbarrow-loads of broken stone to 5 of gravel and ⅓ barrel of cement. The daily capacity of the mixer was about 30 cu. yds., which would allow about 8 minutes for each operation. The labor required was as follows: Two carts to haul material to upper platform, one weigher or tallyman, 4 men loading upper chute, 1 man at middle platform and 3 shovelers at the discharge at bottom, who filled barrows or cars for removing concrete. Three more men removed the concrete and supplied 5 tampers. The concrete was spread in layers from 10 to 12 ins. thick and tamped down. It was kept wet constantly by a separate attendant and each layer allowed to harden before another was added. Rosendale cement was used for all except the upper layer only, the layer in contact with the granite floor-blocks and steps. For this last layer Portland cement was used.

The concrete laying was commenced in May, 1874 but was carried on with frequent interruptions for many years before the walls were finished. Portland cement, at this point, cost $6.50 per barrel in 1874; broken stone cost $3.50 to $4.50 per ton, and gravel $2.50 per cu. yd.

Without going into the detail of the dock proper, the following points may be noted: The Mare Island dock measures abovt 530 ft. between extreme ends, and has an entrance width of 78 ft. The chamber is 461 ft. long, 30 ft. wide on the floor, and 122 ft. wide at the coping, the coping being 36 ft. 6 ins. above the floor. At average high tide the depth of water is 31 ft. 6 ins. in the chamber and 27 ft. at the entrance arch. The dock will accommodate a vessel of 75 ft. beam and 21 ft. draught at low water. The total cost was $2,143,099, and the dock was only completely finished in 1886.

Cement-lined Wrought Iron Pipe vs. Cast-iron.

The use of cement-lined wrought iron pipe for water mains was quite common in New England a few years ago. Several towns are still using it for extensions and several are replacing it with cast-iron as rapidly as possible. Two towns, at least, where public ownership of the water-works prevails, manufacture their own pipe, having a complete plant and experienced workmen for the purpose. These towns are Melrose and Medford, which, with Malden, take their water supply from Spot Pond. Previous to 1889 Malden used cement-lined pipe but since the beginning of that year it has changed to cast-iron, exclusively.

In March, 1889, the people of Melrose, in their town meeting, requested their water commissioners to examine the relative merits of cast-iron and cement-lined wrought iron pipe, with a view of discontinuing the manufacture of the latter if it should appear to be no no better or cheaper than cast-iron.

The water commissioners conducted their investigations by addressing letters to the officials of several water-works, and to one water-works engineer and one contractor, asking for opinions on the subject. The works whose officials were addressed had, some of them, both kinds of pipe in use, while others were using either cement or iron pipe exclusively. The replies received are discussed below. From the testimony given the Melrose water commissioners did not attempt to decide the question presented to them, but submitted to the people instead certain considerations which may be briefly summarized as follows:

Melrose has a complete equipment for manufacturing and laying cement pipe. The chemical action of the water from Spot Pond, the source of supply, causes iron pipe to deteriorate rapidly. As the town has a system [28 miles at the close of 1889] of cement-lined pipe, a change to cast-iron would necessitate an undesirable combination. The difference in cost of the two kinds of pipe, in the judgment of the Commissioners, is so little that the question [in the case of Melrose] is wholly one of superiority.

It will be seen from the above that, while the Commissioners left the question of changing from cement to iron pipe to the decision of the people, they were evidently in favor of continuing the use of cement-lined pipe.

The replies which the commissioners received are abstracted below, those favoring cement pipe being taken first.

Under date of Jan. 20, 1890, Mr. C. L. GOODHUE, Springfield, Mass., wrote that on 4, 6 and 8-in. pipe cement should be about 10% cheaper than cast-iron. Cement pipe, properly made, he thought, would last much longer than cast-iron. If done by contract the chances for poor work were greater with the cement pipe, while the chances for better water was with that kind.

Mr. PERCY M. BLAKE, Hyde Park, Mass., thought that for the sizes mentioned above the cost of pipe and pipe-laying would be 10 and possibly 15% below that of standard cast-iron.

Mr. J. H. PERKINS, C. E., Superintendent of the Watertown (Mass.) Water Supply Co. was in favor of cement pipe as a conductor of water, the trouble being to get a thorough job. Their cement mains had given no trouble.

Mr. CHARLES S. DAVIS, Chairman of the Plymouth (Mass.) Water Commissioners, stated that since 1854 they had used cement-lined wrought iron almost exclusively, as their water is particularly destructive to cast-iron pipe and the cement pipe is entirely satisfactory. Cement pipe laid in 1854 is generally in good condition. It is a question of well made, well laid pipe, with the advantage of no decrease in diameter by rust when cement is used. In 1887 a new supply main was laid and the system changed into two services, a high and a low, the greater part of the old pipe going into the high service. This change occasioned a number of leaks for a short time, but they were easily and cheaply repaired, the average cost of repairs for 1887, 1888 and 1889, including the time during which the change was made, having been $12.74 each for 10, $12.07 for 6 and $6.53 for 4-in. pipe. The cost of quite an extension to the cement pipe system in 1886, including pipe, trenching, backfilling, setting gates and branches (the former supplied), and keeping roadbed in repair for one year was as follows: For 16-in., per lineal foot, $1.90; 14-in., $1.70; 12 in., $1.35; 10-in., $1.05; 6-in., 72 cents; 4-in., 52 cents.

Mr. WILLIAM F. HILL, Superintendent of the Dedham (Mass.) Water Co., stated that they had but little cast-iron pipe in use, and from their experience, if properly laid, there can be no better pipe than cement. The company had, Feb. 11, 1890, over 20 miles of mains, most of which was laid in 1881. Two or three small leaks had been caused by the careless handling of picks when making service connections, and one leak by closing a hydrant too quickly. With these exceptions there had been no leaks in their main pipes, and for more than two years there had been none of any kind on the main pipe line. The cost of laying cement-lined pipe was stated by Mr. HILL as follows: For 10-in., $1.05 to $1.15; 8 in., 85 to 95 cents; 6-in., 70 to 80 cents; 4-in., 50 to 60 cents per foot.

Mr. T. W. MORSE, Superintendent of the Natick (Mass.) water-works, state that the town had about 25 miles of 4 to 12-in. cement pipe, some of which has been in use 16 years. Now and then a few joints leak and two or three times in a year, perhaps, pipe bursts, but these troubles arise from careless work. Mr. MORSE states that there has always been doubt in his mind as to how large a size of cement-lined pipe can be laid with good results.

The Hingham (Mass.) Water Co., says Mr. C. W. S. SEYMOUR, Superintendent, has about 40 miles of 14 to 3-in. wrought iron and cement pipe, most of which was laid in 1879 and 1880, when the works were built. It has given very little trouble from

breaks. The system is under a low gravity pressure. Mr. SEYMOUR would not use cement pipe for pumping systems or in gravity systems having over 30 or 60 lbs. pressure. All things considered, the cost of the two kinds of pipe, he says, is about the same, so "the only recommendation for cement pipe is in its absolute freedom from corrosion and the consequent purity of the water. This is the vital point in all water-works, and with water that will readily attack iron there is no question of the superiority of cement-lined pipe. Otherwise, and with high gravity or pumping pressure, I should say cast iron every time."

The general testimony thus far is in favor of cement-lined pipe, provided good workmanship can be secured; the experience of all seems to show that bad workmanship is a difficulty which can hardly be overcome. The five gentlemen representing water-works have had quite satisfactory experiences with cement pipe. The four remaining works heard from are against the cement pipe, and in all of them it has been given a trial.

Mr. DEXTER BRACKETT, of the Boston water-works has a decided preference for cast-iron, based on experience and observation of the use of both kinds of pipe. He says that the Mystic division of the Boston works, built in 1864 for the supply of Charleston, used cement pipe, and that after 12 years the breaks in the mains were one to each 0.45 miles, while on the Cochituate works the breaks in cast-iron pipe were but one in each 24.4 miles. The entire Charleston distribution system was relaid with cast-iron. Mr. BRACKETT states that cast-iron pipe laid in Boston in 1848 were in service 41 years afterwards, to all appearances nearly as good as when first laid. "When laid in marsh mud cast-iron pipes decay rapidly; but in good earth they will last at least 50 years, and I see no reason why not 100."

Mr. JOHN KIMBALL, President of the Concord (N. H.) Water Commissioners states that their works were built in 1872, with cement-lined pipe, and the pipe has given but little trouble. Lately cast iron pipe has been used for extensions, and would be used if new works were to be built.

Mr. CHARLES K. WALKER, Superintendent of the Manchester (N. H.) works, states that they have laid no cement-lined pipe for 13 years. In taking up cement pipe laid 16 years ago parts are found sound, others with the iron all rusted out, which, he says, shows that it could be so laid as to last a long time. A large part of the cement pipe must be taken up and will be replaced by cast iron.

The Water Commissioners, of Chelsea, Mass., through Mr. O. LOMBARD, Clerk, state that in their judgment "cast-iron pipe is the most reliable, and in the long run the most economical. The first cost is in favor of cement pipe, but in a very few years the difference in favor of cast-iron will more than offset it."

Doubtless the Melrose Commissioners might have extended the testimony on both sides much further, since cement lined pipe is still being used for new works and for extensions to works other than those mentioned above, while, on the other hand, several works are replacing their cement-lined pipe as rapidly as possible by cast-iron.

The testimony above in favor of cement-lined wrought iron pipe may surprise a few, as the prejudice against it in some quarters has been so strong that it has been denounced as almost worthless. However that may be the facts and opinions presented are well worth recording. The information is taken from the annual report of the Melrose (Mass.) Water Commissioner for 1889. J. W. RILEY is Superintendent of the works, and PARKER MERRILL, Registrar.

THE PROPOSED INTERCONTINENTAL RAILWAY is to be surveyed under 10 engineer officers of the army detailed for this duty by Secretary of War PROCTOR, says a Washington dispatch of Jan. 24.

THE JACKET OF THE FIRST AMERICAN 12-IN. GUN was successfully put in its place on the 30-ft. central steel tube, at the Washington Ordnance Factory, on Jan. 27. This steel jacket was made by the Bethlehem Iron Works, and is the main jacket or ring, extending from the breech to several feet beyond the powder chamber. Other rings must follow to complete this first American 12-in., built-up, breech-loading gun. The completed gun will weigh 45 tons, will use a 425-lb. powder charge and 850-lb. projectile, and is expected to develop an initial velocity of 2,100 ft. per second and a striking energy of 25,985 foot tons.

THE PLANS OF THE WORLD'S FAIR ARE TAKING SHAPE, and the designs for the five buildings along the lake front, as prepared by the late JOHN W. ROOT, have been adopted. These include an art palace to cost $1,250,000; the decorative art building to cost $250,000; the water palace, $600,000; electrical exhibits, $75,000, and the music hall, to cost $250,000. Jackson Park has been sub-divided among the various classes of exhibits, preparatory to the erection of buildings, etc.

PURE ALUMINUM is to be sold at retail at $1.25 per lb., says a press dispatch, by vote of the stockholders of the Cowles Electric Smelting & Aluminum Co., at its last meeting. A large quantity of pure aluminum in slabs and ingots was displayed at the meeting. We give this statement for what it is worth, as we have had occasion before to deny similar reports.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Pittsburg, Shenango & Lake Erie.—All but about 23 miles of the track has been laid on the extension from Osgood to Girard Junction, Pa., and the grading has been completed. Work will commence in thespring on a branch from Cranesville, Pa., to Conneaut Harbor, O.

Escanaba, Iron Mt. & Western.—The contractors have completed all the bridge work on the section from Escanaba to Iron Mountain, Mich., and work has been commenced on the division between the latter place and Florence, Wis.

Pennsylvania.—Surveys have been completed for a branch from Williamstown to Minersville, Pa.

New York Central & Hudson River.—It is rumored that this company is negotiating with the Toronto, Hamilton & Buffalo Ry. Co., with a view of securing an entrance into Toronto, Ont. The latter company was chartered to build a line from Welland junction to Toronto, Ont., with a branch from Hamilton to Brantford, Ont., a total of 103 miles. If the present negotiations are completed the route will be changed to connect with the Canada Southern Ry. at the Niagara River and the branch to Brantford will be abandoned.

Boston & Maine.—This company, which secured from the last Massachusetts Legislature the right to increase its capital stock $5,000,000, now asks the Maine State Legislature to concur in that action. According to a statement presented by the company the following improvements are now in progress or are to be commenced:

Double tracking	Saugus Branch	$100,000
" "	Dover to South Berwick	100,000
" "	Ipswich to Salisbury	300,000
" "	Exeter to South Newmarket Junction	150,000
Lynn passenger station		50,000
Land purchased for same		50,000
Land for same to be purchased (estimated)		50,000
Land for freight yard at Lynn		100,000
New rolling stock contracted for		680,000
		$1,710,000

Construction on the branch from Ipswitch to Salisbury, 12 miles, will commence at once, and it is expected to have the work completed by July 1.

Aside from the double tracking already authorized, the executive officers of the road are satisfied that as soon as practicable they must double track 35 additional miles on the Western Division, completing the double tracking of that division at a cost of about $700,000, and about 64 miles on the Eastern Division, completing the double tracking of that division at a cost of about $1,280,000, making a total of $1,980,000.

Ohio & Mississippi.—Work will begin at once on the extension of the Cincinnatti & Bedford R. R. about 2 miles to stone quarries. L. C. Fritch is engineer in charge of work.

Philadelphia & Reading.—This company has obtained control of the terminal facilities in Buffalo, N. Y., heretofore in the hands of Albright & Co., who handled the company's business. This includes the large storage plant at Cheektowaga, capable of storing 350,000 tons of coal, and the facilities necessary for handling it.

Delaware, Lackawanna & Western.—Rumors are in circulation that an effort is being made by people along the route to secure the construction of a branch of this railway from a point near Leroy, N. Y., to Rochester, N. Y. Two surveys were made for the branch some years ago.

Lehigh Valley.—It is reported that a branch of the Buffalo & Geneva R. R., now under construction, will be built to Rochester, N. Y.

Emmittsburg & Gettysburg.—This company has been organized in the interest of the Emmittsburg R. R. Co. to build a railway to Gettysburg, Pa., where connection will be made with the Gettysburg & Harrisburg R. R. The road will be about 11 miles long.

Projects and Surveys.

New York, Philadelphia & Chicago.—Christopher Heydrick, of Franklin, Pa., writes as follows:

This road is projected to run from Franklin, Pa., via Clarion, Brookville, Falls Creek, Du Bois, and Curwensville, to Clearfield, Pa., a distance of 90 miles. The surveys have been completed and about one-third of the right of way has been secured. The route is through a rich agricultural and mineral section; maximum grade 50 ft. per mile, and maximum curve 10°. There will be large bridges at Franklin, Clarion, Brookville, and Curwensville. The principal business of the road will be in coal, oil, fire clay, lumber, and general merchandise. The company was chartered Aug 28, 1890. President, Charles Miller; Chief Engineer, Geo. C. Hamilton, both of Franklin, Pa.

Northern Michigan.—The franchise of this company, which was chartered in 1888 to build a railway from Houghton to Watersmeet, Mich., 70 miles, will, it is stated, be sold to the Milwaukee & Northern R. R. Co. This company will, if the negotiations are completed, construct the road this season.

New Boston.—A bill to incorporate a railway company by this name has been introduced into the New Hampshire State Legislature. The road will run from a point on the Manchester & North Weare R. R. in Goffstown to New Boston, N. H.

Terre Haute & Mississippi River.—C. M. Thompson, of Terre Haute, Ind., writes that there is a possibility of surveys commencing on this road in June. The road is to run from Terre Haute, Ind., to Chester, Ill. H. Hulman, of Terre Haute, Ind., is President.

Grand Rapids, Chicago & St. Louis.—Chas. E. Temple, of Grand Rapids, Mich., writes us that the surveys have been completed from Grand Rapids to Benton Harbor, Mich., 84 miles. The road will be continued to Michigan City, Ind., ultimately, about 40 miles further. The work is generally light; maximum grade, 40 ft. per mile, and maximum curve 3°. About 30 miles of the right of way have been secured. There will be bridges across the Kalamazoo River at Saugatuck and across the St. Joseph River at Benton Harbor. The principal business of the road will be in lumber, stone, coal and general merchandise.

Southern Central.—Geo. D. Snyder, of Dauphin, Pa., writes as follows:

This road is projected to run from a point on the Susquehanna River opposite Sunbury, Pa., along the west bank of that stream to Clark's Ferry, where it crosses the river and continues along the east bank to Dauphin, Pa., where connection is made with the Philadelphia & Reading R. R. The total length of the line will be about 45 miles. The surveys were commenced in December, 1890, and the preliminary line is nearly completed, and about 15 miles have been located. The work will be quite heavy; maximum grade, 3%. There will be a large bridge over the Susquehanna River

SOUTHERN.—Existing Roads.

Macon, Dublin & Savannah.—About 10 miles of the section from Macon to Dublin, 54 miles, remains to be graded. Over 12 miles of track have been laid and it is intended to have the remainder finished soon.

Montgomery, Tuscaloosa & Memphis.—Work on the northern end of this line has been stopped.

Richmond & Danville.—The Danville & New River R. R., of Virginia, which was sold last August under a foreclosure, has been reorganized and next month will become a part of the Richmond & Danville system. Colonel J. Wilcox Brown, of Baltimore, Md., is the principal owner. The reorganized company will issue stock to the amount of $15,000 on each mile operated, which will be turned over to the Richmond & Danville, and on this basis new bonds will be issued. These bonds will be apportioned to the holders of the securities of the old road. The road will be extended westward in an almost direct line to Bristol, Tenn., and will give connection with the Richmond & Danville in that direction.

Atlantic & Danville.—Work is now in progress locating the permanent line of the Danville & East Tennessee R. R. Construction will begin early next month.

East Tennessee, Virginia & Georgia.—This company has made a proposition to extend the Johnson City & Carolina R. R. from Embreeville, Tenn., to Warm Springs, N. C., providing Washington Co., together with Johnson City and the Embreeville Iron Co., subscribe $75,000 in aid of the line.

Paducah, Tennessee & Alabama.—Tracklaying will be completed to Paris, Tenn., Feb. 1. Surveys have been made for a further extension to Hollow Rock, Tenn., 22.1 miles.

Roanoke & Southern.—About $800,000 of the amount necessary to complete this road to Roanoke, Va., have been secured, and the construction of the line will be pushed to that place without delay.

Nashville, Chattanooga & St. Louis.—A bill has been introduced into the Alabama Legislature empowering this campany to build a railway from a point on the Huntsville division southeast to Guntersville. This is the same route over which the Tennessee & Coosa R. R. Co., which is controlled by the N., C. & St. L. is now building, and the object of the bill is to enable the praent company to build under its own charter.—Surveys are

being made for a line from Tullahoma to Lynchburg, Tenn., 20 miles.

Projects and Surveys.

Virginia & Kentucky.—David S. Peirce, of Wytheville, Va., President, writes as follows:

This road is projected to run from Dunville, Va., west via Wytheville and Tazewell C. H., a distance of 210 miles. The surveys have been completed and the right of way is nearly all secured. The route is through a mountainous country, but as it follows the course of the streams the grades will be light. The principal business of the road will be in the coal from the Pocahontas coal fields and iron ore from the mines along the route. About $500,000 aid will be voted by the counties along the line. The road is backed by the Atlantic & Danville R. R. Co., and is projected as a western extension of that road. Contracts will be let in April, 1891. J. C. Wrenshall is Chief Engineer.

Staunton Development Co.—Bids are being received for grading 2¾ miles of standard gage railway through the property of this company. Work will be commenced within 10 days of the awarding of contract. C. R. French, Chief Engineer, Staunton, Va.

Pickens, Arvon & Western.—This company will be chartered in West Virginia to build a railway from Pickens, W. Va., to the headwaters of the Little Kanawha and Holly Rivers, in Webster Co.

Dalton & Gainesville.—A charter has been secured for the construction of the railway between Dalton and Gainesville, Ga., noted last week. Surveys will begin in the spring. C. C. Davis, of Tunnel Hill, Ga., and H. C. Hamilton, of Dalton, Ga., are interested.

North Carolina.—A charter to build a railway from Oxford, N. C., to the Wilmington & Weldon R. R., will be applied for.—The West Asheville & Sulphur Springs Ry. Co. will apply to the North Carolina State Legislature for a Ccharter.—The North Carolina, Cleveland, Chattanooga & Dayton R. R. will apply to the North Carolina Legislature for a charter to build a railway from Murphy, N. C., to Dayton, Tenn.

Florida.—The Orlando & Oakland R. R. Co. has been chartered to build a railway from Orlando to Oakland, Fla. J. M. Cheney of Orlando, Fla., is interested.

Old & New Decatur Belt & Terminal.—Chartered in Alabama to build a railway from Decatur to Mussel Shoals.

NORTHWEST.—Existing Roads.

Ohio & Mississippi.—This company is now locating a line from Cypress Hill, Ill., to Paducah, Ky., a distance of 55 miles. G. M. Walker is the Engineer in charge.

Burlington & Missouri River.—It is rumored that this company will build a line from Alliance, Neb., to Cheyenne, Wyo., and thence via Longmont to Denver, Colo.—The Black Hills branch has been completed to Deadwood, S. Dak.

Port Edwards, Centralia & Northern.—The grading is now completed on this Wisconsin railway and tracklaying is nearly completed.

Chicago & Eastern Illinois.—The right of way has been secured between Tuscola and Shelbyville, Ill., and it is stated that the line will begin at once.

Projects and Surveys.

Sioux City & Northwestern.—It is announced that this company will be ready to receive proposals for construction about March 1. The road is projected to run from Sioux City, Ia., north toward the Black Hills. L. F. Wakefield, Sioux City, Ia., is chief engineer.

Joliet, Lisbon & Western.—Chartered in Illinois to build a railway from Joliet, Ill., west through Will and Kendall counties, to a point on the Fox or Illinois river in La Salle Co. Among the incorporators are: Levi Platt, Plantsville, Ill.; Jas. Johnson, Lisbon, Ill., and F. L. Stephen, Newark, Ill.

SOUTHWEST.—Existing Roads.

Kansas City, Fort Smith & Southern.—A. M. Nelson, of Springfield, Mo., Chief Engineer, writes us that this road was extended from Splitlog Junction, Mo., to Sulphur Springs, Ark., 22¼ miles.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—Work on the northern extension of the Seattle, Lake Shore & Southern R. R., is making rapid progress. Chief Engineer Talcott is reported as saying that the track has been laid to Black slough about 3 miles north of the south fork of the Nooksack. The superstructure of 1,000 ft. trestle has to be built across this slough and will be finished in short time, so that the track may reach the north fork by Monday. A pile driver is at work 5½ miles south of the boundary and is working its way southward. In the next 5 miles it has to do piling for 9 small bridges and has several sloughs of the Nooksack to pile. When the superstructure has been put on these bridges everything will be ready for track as far as the boundary, and rails will then be laid at the rate of 1½ miles a day. There still remains about 19½ miles of track to lay. The contract has been let for a line from a point near Anacortes, Wash., to the Blue Canyon coal mines, a distance of 9 miles. The line is to be completed in 90 days.

Great Northern.—It is probable that the grade of the Seattle & Montana R. R. will be ready for tracklaying by March 1. From the point of connection with the Fairhaven & Southern to Stanwood, a distance of 18 miles, it will be finished in about two weeks, and from Stanwood to Marysville, it will be finished in four weeks. Of the latter section, the stretch between the Stillaguamish River and Marysville is already finished, and the heaviest work to be done—about two miles of bridging at the mouth of the Stillaguamish—is progressing well. Good progress is being made with the cribbing along the shore south of that point. The only breaks in the line are due to right of-way difficulties at a few points.—Work is now being pushed ballasting the Fairhaven & Southern R. R.—The contract for building the section of the Pacific extension from the summit of the Rocky Mountains to the Kootenai River has been let to Shepard, Siems & Co., of St. Paul, Minn.

Seattle & Northern.—It is announced that this road has now been completed to Hamilton, Wash.

Union Pacific.—It is stated that work on the Pioche extension will be resumed about March 1. The total length of the line from Milford, Utah, to Pioche, Nev., is 140 miles. The grading has been nearly completed, and about three miles of track have been laid. It is expected to have the line completed by July 1.

Projects and Surveys.

Spokane & Northwestern.—The preliminary survey for this line from Tacoma to Port Angeles, Wash., has been completed, and a very favorable route is reported to have been secured. The grades will not exceed 3 or 4 per cent.

Yaquina, Seal Rock & Alsea.—The right of way is being secured for this railway between Yaquina and Alsea bays.

Airlie, Toledo & Nashville.—Chartered in Oregon to build a line of railway. Among the incorporators are: Chas. Kennedy, W. H. Rich, W. M. Jones and A. L. Porter.

San Francisco & San Mateo.—A railway company by this name has been chartered in Oregon. Among the incorporators are: J. H. Gilmore, J. W. Hartzell and W. F. Thomas.

FOREIGN.

Mexican Central.—A press despatch says:

The Mexican Central Ry. Co. expects to soon resume construction work in Mexico, and arrangements with that end in view are now being consummated. Probably the first work to be undertaken will be the partly finished Colima branch, as it is believed that its construction will result in a great increase in traffic to the Mexican National, with which it connects at Gaudalajara. Colima is on the Pacific Ocean, and many improvements have been made at the harbor. This line will be about 140 miles long. Among other extensions upon which work may soon be commenced is one from Ojo Caliente, on the Zacatecas division west to Montezuma, in the State of San Luis Potosi, on the main line of the road, about 60 miles, and also a a line between Salvatierra, Ramora, La Barca and Gaudalajara, passing north and south of Lake Chapala. This is good for East Texas lumbermen.

CITY TRANSIT.

Electric Railways.—New lines or extensions are proposed in the following cities: Washington, D. C., address B. C. Pole; Pittsburg, Pa., address the Suburban Rapid Transit Street Ry.; Louisville, Ky., address the Central Pass R. R.; between Anniston and Piedmont, Ala.; Chicago, Ill., address the South Chicago Electric Ry.; Knightstown, Ind., address the Indiana Soldiers' and Sailors' Home; Columbia, S. C.; Port Angeles, Wash.; Portland, Ore.; Derby Depot, N. H., address Prof. C. S. Campbell.

Rochester, N. Y.—The Ridge Road Improvement Association proposes building an electric railway to Niagara Falls, the power being supplied from hydraulic machinery.

Troy, N. Y.—The stockholders of the Troy & Albia R. R. have decided to increase the capital stock in order to raise funds for an electric plant.

New York City.—The application of the Harlem Bridge, Morrisania & Fordham Ry. for permission to use the overhead trolley system in the Annexed District has met with great opposition from the adjoining property owners.

West Salamanca, N. Y.—The Board of Trustees of the village will sell at public auction at their office at 10 A. M., Jan. 30, the franchise to construct and operate an electric railway on a number of streets.

Pottsville, Pa.—At the last annual meeting of the Schuylkill Electric Ry., a committee of the Board of Directors was appointed to ascertain the increase of stock necessary to extend the system to Tumbling Run, Palo Alto, Port Carbon and other suburbs.

Washington, D. C.—The Eckington & Soldiers' Home Electric Ry. has, it is said, contracted with a storage battery company to operate its recently constructed lines by these batteries for a term of three years. The railway is to suffer no loss, according to the terms of the contract, if the system is not a success.

Asheville, N. C.—Gudger, Carter & Martin have given notice that they will apply to the legislature for a charter for a street railway to Biltmore, to be operated by electricity, steam or other motive power.

Rome, Ga.—Chattanooga parties are reported to have purchased the Rome Street Ry., and the Rome Dummy Line, and will change them to electric lines.

Atlanta, Ga.—The Atlanta Street Ry. will, it is reported on the authority of President A. E. Thornton, lay double tracks throughout its entire system and use electric motive power exclusively.

Covington, Ky.—The rails on the track to Cincinnati will be replaced by heavier steel sections before the electrical cars are run. The wiring is now finished and being tested.

Louisville, Ky.—A local newspaper states that Boston parties will build a road through a number of streets extending to the southern suburbs. The contracts are said to have been made, and the road is to be in running order by April 15.

Knoxville, Tenn.—The Beaumont Street Ry. Co., will build a 5-mile line, it is said. The motive power will be either electricity or steam, probably the former.

Chattanooga, Tenn.—The Chattanooga Electric Ry. wants bids for furnishing electric supplies.

Cincinnati, O.—The Mt. Auburn Cable Ry. has applied for permission to lay a number of single and double tracks, to be operated by electricity or other improved motive power.

Pine Bluff, Ark.—The Citizens' Street Ry. has increased its capital stock to $200,000, and will convert its line into an electric railway.

Fort Worth, Tex.—The Polytechnic Street Ry., M. F. Lomer, Secretary, wants bids for furnishing rolling stock, with either steam or electric motive power.

Dummy Railways.—***Greenville, S. C.***—It is said that the contract for grading the proposed dummy railway to Paris Mountain has been let.

Pensacola, Fla.—The property of the Pensacola Street Car Co. has been purchased by Baltimore parties, who, it is reported, will extend the line about 10 miles and use dummy engines for long distances.

Independence, Mo.—Articles of incorporation have been filed for the Kansas City & Independence Air Line, with a capital stock of $150,000. The incorporators are all Kansas City men except A. A. Mosher, of St. Louis. It is stated that the surveys have been made and part of the rolling stock ordered. It is expected that the road will be completed by June 1.

Riverside, Cal.—The Board of Trustees has passed to a second reading an ordinance granting right of way on several streets to the Southern California Motor Road.

Horse Railways.—***Cincinnati, O.***—G. R. Werner, E. Locke and F. W. Freeman have applied for a franchise to lay and operate a double track railway on a number of streets.

Llano, Tex.—A street railway will probably be built to connect North and South Llano. W. H. Miller can give information.

San Francisco, Cal.—An application for a street railway franchise has been received by the Supervisors from G. Hearst, A. C. Doble, J. C. Stump and others.

New Companies.—Gloversville, N. Y., Electric Ry.; capital stock, $70,000; directors, D. P. Judson, S. H. Shotwell, D. F. Cowles and others. Dunkirk & Fredonia Rapid Transit Co., Dunkirk, N. Y.; capital stock, $90,000; incorporators, O. W. Johnson, Wm. Martin, J. R. Patterson and others. Fulton & East Clinton Street Ry., Fulton, Ill.; capital stock, $20,000; incorporators, T. A. Hard, G. S. Sarden, Clarence Green. Gravesend, Flatbush, Flatlands & Brooklyn R. R., Brooklyn, N. Y.; incorporators, S. S. Williamson, J. G. Tighe, A. Hodges and others.

HIGHWAYS.

New York.—At a meeting of the Genesee Co. Farmers' Club on Jan. 20 the following resolution was passed: That farmers should spend more time and labor on the highways in their own neighborhood, and have the roads better improved than they now are; and that better roads would be greatly to the advantage of the farmers. The Board of Supervisors of Westchester Co. recommends legislation for the repeal of the present laws governing general road repairs throughout the State, and the passage of some measure which shall insure greater efficiency. In their judgment a certain sum of money should be appropriated annually by the State at large to be used in the work of road improvement in addition to moneys now raised by the various towns for that purpose, and such moneys should be expended under the care and direction of competent engineers. They request their Senator and Assemblymen to take action on the matter.

Texas.—The Houston *Post* says that Texas wants a general system of country roads, but that the system must be built up in each part by the people who use it. It approves of the plan suggested by Gov. Seay, of Alabama, in which each township would build its roads, rather than the plan of Gov. Hill, of New York, by which the State would undertake the construction of county roads.

BRIDGES, TUNNELS AND CANALS.

Allegheny Co., Pa.—The report of the Allegheny Co. engineer contains the following estimates of expenditures for bridge construction for the present year:

Amount required for renewal during coming year, $30,500; amount required to construct 14 new bridges authorized, $42,800; amount required to complete work under contract, Jan. 1, 1891, $3,508; amount required for repairs and maintenance, $8,000; total, $84,808.

Suspension Bridge, N. Y.—Bridge Engineer L. L. Buck, of the Grand Trunk Ry., has, it is stated, prepared plans for the building of a stone arch bridge by the side of the present railway suspension bridge, to be used for freight purposes, leaving the present structure for the use of passenger trains only. These plans have been adopted by the company, and the new bridge will be built in the near future.

Saginaw, Mich.—R. W. Roberts, City Engineer, informs us that two draw bridges of 400 ft. span each and one of 320 ft. span will be built across the Saginaw River.

Milwaukee, Wis.—A viaduct about 2,000 ft. long will probably be built across the Menominee Valley this year.

Canals.—The survey of the contemplated ship canal connecting Lakes Union, Washington, and Samamish, authorized by the river and harbor bill of last session, is nearly completed. A corps of 31 engineers, in charge of P. G. Eastwick, have been employed on this work since October. When completed the details will be taken to Portland, and the projects, plans and estimates of the canal will be made by the Board of Army Engineers, consisting of Major Handbury, Colonel Mendell and Captain Symmons.

WATER-WORKS.

NEW ENGLAND.

Turner, Me.—Works for fire protection are projected.

Derry, N. H.—F. R. Felch, Derry Depot, Secretary, informs us that the Derry Water-Works Co. put works in operation Jan. 1. Water is pumped to a stand-pipe.

Groveton, N. H.—The Groveton Water Co. has been incorporated; capital stock, $6,000.

Manchester, N. H.—At a recent meeting of the water commissioners an increased supply and a high pressure system were discussed. Nothing definite was decided upon. C. K. Walker is Superintendent.

Salem, N. H.—The Salem Water-Works Co. are before the Legislature for incorporation.

Easthampton, Mass.—On Feb. 5 the State Committee on Water Supply will give a hearing at the State House to parties interested in the petition of John Mayher and others for authority to supply the town with water for domestic and fire purposes, and the right to take water from various places near Mt. Tom and convey it to a reservoir.

Holliston, Mass.—The following is from J. D. Shippee, Secretary:

The Holliston Water Co. expect to put their works in operation sometime during the summer. The principal contracts have been let. Water will be pumped from wells and springs to a stand-pipe 30 × 60 ft. Population, 3,000.

Providence, R. I.—The General Assembly will be petitioned for authority to issue $500,000 water-works extension bonds.

East Hartford, Conn.—The following is from Perry S. Bryant, Hartford, Conn.:

There are fair prospects of the construction of works during the coming season by the East Hartford Water Co. The fire district has not yet contracted for hydrants. The company has a capital stock of $100,000, with enough paid in to cover the cost of preliminary surveys. E. J. McKnight, East Hartford, is President of the company. Population, 4,300.

New Britain, Conn.—G. H. Pease, Mayor, informs us that they will have to increase their water supply and are now considering plans, but no definite action has yet been taken.

MIDDLE.

Millerton, N. Y.—Works are projected.

Rochester, N. Y.—S. B. Roby has written to the Rochester *Union and Advertiser* advocating a water supply from Lake Ontario of 20,000,000 galls. a day, which could be increased to about 30,000,000 galls. a day by adding more pumps. The plan includes two miles of 7-ft. lake tunnel, two pumping stations, each with two 20,000,000 Gaskill pumping engines and a battery of 16 5 × 15 ft. boilers, 8 miles of 4-ft. cast-iron pipe, and three masonry and steel stand-pipes. The estimated cost is $2,000,000. The plan is unofficial and based upon those previously presented by Messrs. Fanning & Fteley and J. Nelson Tubbs.

New Brunswick, N. J.—It is reported that several miles of cement-lined pipe will be replaced by iron, and that 150 tons of the latter will be purchased. C. H. Cramer is Superintendent.

Lebanon, Pa.—A press dispatch states that at a special meeting of the water commissioners and city committee on Jan. 24 it was decided to build a new impounding reservoir on South Mt., near the present source of supply, the reservoir to have a capacity of over 40,000,000 galls. W. J. Burnside is City Engineer and H. M. Allwein Superintendent of water-works.

SOUTHERN.

Berryville, Va.—T. S. Thompson, Secretary Berryville Water Co., informs us that all bids for the construction of works have been rejected; that the specifications are being revised, and that new bids will be received until March 2.

Pulaski City, Va.—It is reported that the Norfolk & Western R. R. Co. will put in a new pump and boiler here. The offices of the company are at Roanoke.

Hickory, N. C.—Address the Mayor regarding works projected by the town.

Morganton, N. C.—The Morganton Development Co. has been incorporated to erect mills, water-works, etc.; capital, $500,000.

Chester, S. C.—Works are projected. Address the Mayor.

Cedartown, Ga.—Thomas McMeekin informs us that an attempt to build works is being made. Address I. K. Barton or Charles Adamson.

Fort Valley, Ga.—J. A. Houser, Mayor, informs us that at an election held Jan. 24 bonds for works were voted by the town, there being 167 legal votes cast, all in favor of bonds.

Knoxville, Tenn.—The City Council has voted down the ordinance providing for extensions to the company's works.

Trenton, Tenn.—Construction will be started some time this Spring. G. C. Morgan, 15 Major Block, Chicago, is Engineer and Contractor. Water will be pumped from driven wells to a Morgan's tower. There will be 3 miles of mains and 33 hydrants.

Fulton, Ky.—G. C. Morgan, Engineer and Contractor, will begin construction in the Spring. Water will be pumped from an open well to a Morgan's tower. There will be 3½ miles of mains and 43 hydrants. Population, 3,000.

Harrodsburg, Ky.—Plans and specifications for works are being prepared by Jas. P. Herdie, Williamsport, Pa.

NORTH CENTRAL.

Carthage, O.—Laidlaw & Dunn Co., Cincinnati, O., are contractors for the new works.

Cincinnati, O.—The contract for two high pressure horizontal pumping engines with a combined capacity of 3,350,000 galls. has been awarded to the Gordon Steam Pump Co., Hamilton, O., for $3,666 each.

Eaton, O.—The following is from John W. Hill, Cincinnati, Engineer:

Plans and specifications have been prepared, and a vote will be taken in the spring upon the issuance of bonds for works, to cost about $67,000, not including real estate. It is proposed to drive six 6 in. wells on the west bank of Seven Mile Creek, ¾ miles from the village. A 12 in. pipe to the creek would provide for emergencies. Two 750,000-gall. compound condensing duplex direct-acting pumps will force water through a 12-in. main to a stand-pipe 20 × 80 ft. on a masonry base 50 ft. high. There will be 9 miles of 12 to 4-in. cast-iron pipe, 74 double 4-in. hydrants and 56 valves.

Hicksville, O.—J. D. Kerr, Mayor, informs us that the village put direct pumping works in Jan. 1. J. D. Cook, Toledo, O., was Engineer.

Marysville, O.—The works were completed Jan. 28, with J. W. Hill, Cincinnati, Engineer.

Huntington, Ind.—The Huntington Water-Works Co. will complete their plant about May 1. The contracts were let some time ago. Water will be pumped from driven wells for domestic, and from the Wabash River for fire purposes. Engineer, J. W. Hill, Cincinnati; President and Manager, William McGrew.

Princeton, Ind.—C. W. Benton, City Clerk, informs us that T. R. Paxton has applied for a franchise, and that it will probably be granted to him. If so, water will probably be pumped to a stand pipe.

Terre Haute, Ind.—The 3,000,000-gall. National filtering plant will be enlarged.

Coldwater, Mich.—The construction of works was begun in September, and they are now nearly completed. Pumps are used. J. D. Cook, Toledo, is Engineer.

Imlay City, Mich.—The town works were tested and accepted Jan 24. Water is pumped to a tower. There are 2½ miles of mains. Engineer and contractor, G. C. Morgan, Chicago.

Ironwood, Mich.—The following is from J. J. Shea, Recorder:

Heretofore the town has been supplied by a company jointly with Hurley, Wis. The future supply will be furnished by the Ironwood Water-Works Co., who are putting in a new reservoir, and will erect a new pumping station so that our supply will be entirely independent of that at Hurley. C. L. Hyde is President, Frank Wynde Secretary and George Stevens Engineer of the new company.

Saginaw, Mich.—R. W. Roberts, City Engineer, has sent the following:

Plans and estimates for a new water supply have been prepared and are now under consideration; estimated cost, $100,000.

Chicago, Ill.—It is reported that two new 24,000,000-gall. pumps will be placed in the Hyde Park station.

Elmhurst, Ill.—The Elmhurst Spring Water Co. will have works, including pump, water tower and 3 miles of pipe in operation by Feb. 15. G. C. Morgan, Chicago, is Engineer.

Hinsdale, Ill.—The following is from G. C. Morgan, Chicago, Engineer:

The village proposes to let contracts within 30 days for works estimated to cost $44,000. The supply will be from an artesian well which will discharge into a 60,000-gall. reservoir. From the reservoir a 1,000,000-gall. pump will lift water to a 30,000-gall. Morgan tower. There will be 7 miles of pipe and 49 hydrants. Population, about 2,000.

NORTHWESTERN.

Iowa Falls, Ia.—A proposition to construct works is under consideration.

Kendrick, Ia.—It is reported that the town will build works.

Sioux City, Ia.—The City Council has again awarded a contract for a temporary water supply, this time to the National Water Supply Co., Cincinnati, for about $27,000. The price includes the development of a daily supply of 2,500,000 galls. from Wagner steamed wells, and machinery to pump the same. The first contract was awarded to Godfrey & Meals, Fremont, Neb., but was withdrawn.

Hamburg, Neb.—The new town works have been tested. Water is pumped to a reservoir, and there are two miles of mains. E. A. Rudiger, Nebraska City, was Contractor.

Hebron, Neb.—The water-works well has been completed. It is 24 ft. deep.

Oakland, Neb.—J. W. Holmquist has sent the following:

Bonds have been voted for works estimated to cost $7,000. Water will probably be pumped from wells to a stand-pipe.

Tekamah, Neb.—E. B. Atkinson, clerk, has sent the following:

A petition has been presented asking that an election be called to vote bonds for works estimated to cost $25,000; supply, wells, pumping to reservoir. Population, 1,800.

Butte, Mont.—The *Inter-Mountain* states that the Butte Water Co. has preliminary surveys nearly completed, under the direction of engineers Ray & Leonard. Also that the company will soon be incorporated with a capital stock of $2,000,000.

SOUTHWESTERN.

Missouri.—Edgar B. Fay, Kansas City, informs us that estimates are being made for works at Brookfield Columbia, Fayette, Kirksville and Richmond, Mo.

Macon, Mo.—The following is from Edgar B. Fay, 503 Delaware St., Kansas City:

Works to be owned by the town will be completed about Feb. 1. The Western Engineering Co. are Engineers, and John Maxwell Contractor, both of Kansas City. Direct pumping is used, and there are 3½ miles of mains.

Arkadelphia, Ark.—The Arkadelphia Water & Light Co. has been incorporated; capital stock, $50,000.

Galveston, Tex.—The city will issue $1,240,000 of bonds for water-works and other extensions.

Corpus Christi, Tex.—A resident informs us that the Corpus Christi Water Co. proposes to construct works at an estimated cost of $200,000, bringing the water from a river 14 miles distant. The plan includes a stand-pipe. Population, 5,500.

Trinidad, Col.—The Trinidad Water-Works Co. has succeeded in obtaining a permanent injunction against the city, preventing the issuance by the latter of $100,000 of bonds for the construction of water-works. In a later issue and in other columns we hope to say more about this case.

PACIFIC.

Montesano, Wash.—A. E. Griffiths has sent the following:

The town has granted a franchise to and made a hydrant contract with James K. Murphy, Seattle, but no steps toward construction have been taken. The supply will be from Silver Creek. Population, 1,000.

Port Townsend, Wash.—The Mount Olympus Water Co. has let a contract for works, as previously described, to the United States Construction & Pipe Manufacturing Co., of San Francisco, Cal.

Santa Ana, Cal.—The following is from E. Tedford City Clerk:

The city has sold $60,000 of water bonds to M. M. Cruikshank, Oakland, at par. Plans and specifications have been made, and as soon as they are accepted, bids for works will be desired.

Santa Cruz, Cal.—C. J. Lincoln informs us that the city put gravity works in operation Jan. 1. There are 30 miles of pipe. These works are independent of the company's plant.

Stockton, Cal.—It is reported that W. S. McMurty, Jr., has purchased the plant of the Stockton Water-Works Co., and will double the pumping capacity and extend the mains.

Provo City, Utah.—A committee of the Chamber of Commerce has reported to that body in favor of the employment by the City Council of an engineer to make surveys for a new canal to bring water to the city for irrigating purposes, and to a reservoir, from which a supply main for water-works could be laid.

ARTESIAN WELLS.

Chattanooga, Tenn.—The Chattanooga Brewing Co. has awarded the contract for three wells to the Kentucky Oil Co.

Harlem, Ill.—A well is being bored.

Keokuk, Ia.—It is reported that J. C. Hubinger will sink his artesian well 125 ft. deeper. It is now 2,100 ft. deep. It is said that all the wells about Keokuk have lately diminished in flow.

Springfield, S. Dak.—The 8 in. well has been tested and shows a flow of 3,251 galls. per minute. The well is 502 ft. deep and throws a solid 8 in. column of water 12 ft. above the surface, or through a 2-in. nozzle to a height of 72 ft.

Belton, Tex.—Fowler & McGilney are contractors for artesian well to be sunk here.

Baden, Cal.—(P. O. Colma Station). The South San Francisco Land & Improvement Co. will sink four or five wells here and build a reservoir. An existing well 330 ft. deep yields 400,000 galls. a day.

IRRIGATION.

Arickaree, Cal.—The Arickaree Valley Association has been organized by the farmers of the vicinity to construct irrigation works. The underflow will probably be developed. S. Lemon is President and A. H. Barclay Secretary of the association.

SEWERAGE AND MUNICIPAL.

Sewers.—***Newton, Mass.***—The report of the Sewerage Committee has been adopted, and the committee authorized to advertise for bids for sewer pipe. The appropriation for the work is $400,000.

Providence, R. I.—It is proposed to issue bonds for $2,000,000 for sewers. Work is in progress on 2¾ miles of

main sewer for draining the Elmwood district. The sections are 80, 100, 108 and 110 ins. diameter, 70 × 76 ins. and 86½ × 94 ins., horse-shoe shape. The circular portions have an egg shaped rider sewer, 18 × 27 ins. to 28 × 42 ins.; this is to carry sewage, the large sewer carrying storm and ground water only.

Norwich, N. Y.—The appointment of a sewer commission to lay out a complete system of sewerage is comtemplated. At present there is only surface drainage. J. P. Alids is city engineer.

Bryn Mawr, Pa.—Col. Geo. E. Waring, Jr., is preparplans for disposing of the sewage of the Bryn Mawr Hotel.

Wayne, Pa.—Col. Waring has charge of the construction of a system of sewage disposal by surface irrigation on lands below the town.

Baltimore, Md.—The Mayor's annual message calls attention to the necessity of adopting some general system of sewage.

Old Point Comfort, Va.—Col. Geo. E. Waring, Jr., has been engaged to prepare plans for the sewerage of the whole reservation, including Fortress Monroe.

Goldsboro, N. C. It is proposed to issue $50,000 in bonds for a sewerage system.

Anderson, Ind.—The City Engineer, Mr. Hy. Rawle, has been authorized to consult Col. Geo. E. Waring, Jr., concerning plans for sewerage.

Saginaw, Mich.—Plans for a sewerage system for the western district have been prepared by the City Engineer, Mr. R. W. Roberts. Estimated cost, $50,000.

Winona, Minn.—The report made by Mr. Chester B. Davis, M. Am. Soc. C. E., of Chicago, recommends the separate system of sewerage, and adoption of the Shone system. The Shone system had been recommended before, but defeated, but the council has now adopted a resolution in its favor, and has had an interview with Mr. U. H. Broughton, engineer and manager of the Shone Hydro-Pneumatic Sewerage Co.

Streets.—*Dunkirk, N. Y.*—The Street Improvement Committee has submitted two plans for distributing the cost. In one the property owners will pay the total cost of the work in front of their property, and the city will pay for the intersections. In the other, the city will pay $1.50 per sq. yd. and the cost of crossing stones at intersections, and 50 cts. per sq. yd. toward the cost of work in front of private property.

Washington, D. C.—Work on the asphalt paving of the extension of Fourteenth St. is to be commenced in May. The appropriation for the work is $12,300.

Athens, Ga.—The city is carrying on the work of paving the sidewalks.

Detroit, Mich.—The Mayor is in favor of asphalt paving on Woodward Ave.; he estimates that it will be $1 per sq. yd. cheaper than dressed Medina blocks on a concrete foundation.

Peoria, Ill.—It is proposed to lay an asphalt pavement on Moss Ave.

ELECTRICAL.

Electric Light.—New plants or additions to existing stations are proposed at the following places: Culberson, N. C., address the Motla Consolidated Marble, Iron & Talc Co; Danville, Va., address the Mayor; Edinburg, Ill., address the Edinburg Coal & Iron Co.; Louisville, Ky., address H. Knirihm; Lake Charles, La., address the Mayor; Springfield, Ill., address J. McCreery, East Lake, Ala.; St. John, N. B., address the Mayor.

Washington, D. C.—The United States Electric Lighting Co. has applied for permission to lay a number of underground conduits.

Richmond, Va.—At a recent joint meeting of the Finance and Electric Light Committees it was decided to recommend to the City Council that $75,000 be appropriated for a municipal electric light plant.

Bristol, Tenn.—The organization of a company with $100,000 capital stock for erecting an electric and gas lighting plant. A. H. Leftwich is President, T. H. Fox, Secretary.

Chattanooga, Tenn.—It is reported that the different railways entering the city will erect a joint electric light plant C. H. Hudson, of Knoxville, can give further information.

Columbus, O.—Bids will be received by the Board of Public Works until Feb. 4 for furnishing for five years 800 or more arc electric lights of not less than 2,000 c. p., together with all the poles, lamps, globes, and materials necessary.

Crawfordsville, Ind.—The Light Committee of the City Council will, it is said, contract for street lighting service with the Crawfordsville Water & Light Co. The committee has visited several places, and after an examination of the lights furnished, has decided that municipal ownership would not be expedient if the local company will reduce its rates to $50 for arc and $18 for incandescent street lights, and supply private parties at a reduction of 33⅓% from the present prices.

Union City, Tex.—A bill has been introduced in the legislature to incorporate the Union City Water Co., with power to erect and operate water-works, an electric light plant and an ice factory.

New Companies.—Grand Rapids, Mich., Electric Light and Power Co.; capital stock, $15,000. Ougley Electric Co., Trenton, N. J.; capital stock, $750,000; trustees, T. W. Robertson, of Orange; H. H. Hall, of East Orange; J. T. Thompson, of West Islip, N. Y., and others. Chicago, Ill., Electric Protective Co.; capital stock, $100,000; incorporators, M. Simons, W. M. Lawley, F. S. Weigley. Princeton, Ill., Electric Light and Power Co; capital stock, $15,000; incorporators, H. H. Ferris, D. Knight, J. A. Stean and others.

CONTRACTING.

Dredging.—*Ogdensburg, N. Y.*—The following proposals for dredging 270,000 cu. yds in Ogdensburg harbor have been received by Major M. B. Adams, U. S. Engineer Office, Burlington, Vt.; Dennis Lynch and John Hannan, Ogdensburg, N. Y., 11 cts. per cu. yd.; Jos. R. McCollum and James Lee, Welland, Ont., 11.2 cts.; Wm. S. Malcolm, Jr., Oswego, N. Y., 12⅝ cts.; Wm. J. Daly, Ogdensburg, N. Y., 12.9 cts.; E. M. Payn, Albany, N. Y., 13¾ cts.; Carkin, Stickney & Cram, Saginaw, Mich., 17 cts.; E. H French, Fulton, N. Y., 19.9 cts.; N. B. Connaly and N. Connaly, Oil City, Pa., and Kingston, Ont., 20 cts.; E. B. Seward, Albany, N. Y., 23 cts.

New York, N. Y.—The only proposal received by Lt. Col. G. L. Gillespie, U. S. Engineer Office, for dredging 500,000 cu. yds. in the main ship channel was from the Joseph Edwards Dredging Co., at 23.9 cts. per cu. yd. The lowest bid for dredging in the Hudson River between New Baltimore and Troy, was from E. M. Payn, Albany, N. Y., 21.9 cts. per cu. yd. at Washington Bar, 19 cts. at Fish House Shoal, 17¾ cts. at Winnies Bar, 18.9 cts. at Mill's Crossover.

Washington, D. C.—The District Commissioners have received bids for dredging the James Creek canal: G. C. Forbes, 26 and 39 cts. per cu. yd. for two sections; T. P. Morgan, 23 and 34 cts.; F. C. Summers, 25¼ and 37½ cts.; Baltimore Dredging Co., 24 and 36 cts.

Armory.—*Brooklyn, N. Y.*—All the bids for the Thirteenth Regiment armory have been rejected as too high, and new proposals will be received until Feb. 10. The amount available is $300,000.

Jetties.—*Galveston, Tex.*—The contract for stone, and jetties for the improvement of the harbor has been awarded to J. H. Mooney and A. M. Newton, of New York, at $2,018,220 for sandstone rip-rap and granite blocks. The prices of bids were given on pp. 45 and 72.

Street Work.—*Seattle, Wash.*—The contract for the improvement of Joy St. has been awarded to E. F. Murphy & Co.; 20 cts. per cu. yd. for excavating; clearing, $126 per acre; timber for sidewalk, $16 per 1,000 ft. B. M.

PROPOSALS OPEN.

Pipe and Castings.—*Newark, N. J.*—Furnishing 1,000 water pipes 24 ins. diameter, 110 pipes 12 ins. diameter; also special castings, except gates. The Aqueduct Board. Feb. 2.

Bridges.—*Kansas City, Mo.*—Two iron bridges, 40 and 60-ft. span, 2 stone abutments. F. J. O'Flaherty, County Surveyor. Feb. 7.

Oakland, Cal.—Steel highway drawbridge across Tidal canal. Col. G. H. Mendell, U. S. Engineer Office, San Francisco, Cal. Feb. 28.

Street Work.—*Cincinnati, O.*—Grading, curbing crossings, vitrified brick paving, culverts, etc. The Board of City Affairs. Feb. 7.

Building.—*Brooklyn, N. Y.*—Armory for the 23d Regiment. The Armory Commissioners, 280 Broadway, New York City. Feb. 10.

Jail.—*Kansas City, Mo.*—Steel and iron cells for Jackson Co. A. Van Brunt, architect, 200 W. 6th St. Feb. 15.

Irrigation Works.—*Maxwell, Cal.*—Headgate and conduit under Stony creek. R. De Lappe, Secretary, Central Irrigation District. March 4.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive & Machine Works, of Paterson, N. J., have delivered 4 eight-wheel passenger engines to the Louisville, New Albany & Chicago. The Brooks Locomotive Works, of Dunkirk, N. Y., have an order for 10 ten-wheel engines for the New York, Chicago & St. Louis; they will have cylinders 19 × 24 ins., and driving wheels 50 ins. diameter, and will be fitted with the Westinghouse air brake and American steam brake.

Cars.—The Ohio Falls Car Co., of Jeffersonville, Ind., has built 100 freight cars for the Southbound road. The Wagner Palace Car Co. of Buffalo, N. Y., will put up a new brick and stone building, 140 × 158 ft., accommodating 23 tracks. A new transfer table is to be built. The company built 70 cars last year. The Laconia Car Co., of Laconia, N. H., has an order for 20 passenger cars for the Boston & Maine. The Gilbert Car Mfg. Co., of Troy, N. Y., has an order for a fish car for the use of the New York State Fish Commission; the tanks and boxes for fish will be arranged in rows and at one end will be a room for the attendants. The Kansas City Car & Wheel Works have been shut down.

The Reading Rolling Mill Co., of Reading, Pa., opened its extensive new works on January 20th; a large number of visitors were present. President, Francis H. Saylor; Vice-President, Jos. H. Cofrode; Secretary and Treasurer, P. R. Foley; Superintendent, Wm. Brazier; Manager, W. H. Lutz. The works were originally started as a rail mill, in 1867, by the Philadelphia & Reading R. R.; the present company acquired the plant in 1889, and has made extensive additions and improvements for turning out all kinds of structural iron.

Railway.—W. S. Proskey, 371 Fulton St., Brooklyn, N. Y., wants bids for building and equipping 40 miles of light standard gage railway.

The Chapman Valve Co., of Indian Orchard, Mass., has completed an addition to its works.

The Berlin Bridge Co., of East Berlin, Conn., has increased its capital stock from $125,000 to $300,000, for the purpose of improving its plant, and will put up a new building 80 × 600 ft., which is to be completed by July. During the past year the company shipped about 8,000 tons of iron in bridges, buildings and roofs; the sales amounted to nearly $1,000,000. The new stock has been subscribed for by the present stockholders.

Pulsometers.—The Pulsometer Steam Pump Co., of New York, has been awarded a gold medal for the pump exhibited at the recent exposition at Spokane Falls, Wash. The points mentioned are simplicity in construction, durability, cheapness of operation, volume of water, and capacity to handle mud, sand, gravel, etc., without injury to the pump.

Car Heating and Ventilation.—The Consolidated Car Heating Co. has contracts from the Canadian Pacific and the "Soo" line; the McElroy commutator and Sewell coupler are specified. The company has also orders from the Boston & Maine, Old Colony, Fitchburg and Grand Trunk roads. The Brooklyn City R. R. is experimenting with the Creamer system of ventilation on some of its street cars. The Dean heater has been applied to the cars of the Niagara Falls & Suspension Bridge R. R.

Drills.—In the construction of the Zig-Zag tunnel on the New York, Ontario & Western Ry., 3 drills were used, 2 of them being of the new "Sergeant" pattern made by the Ingersoll-Sergeant Rock Drill Co., of New York. The tunnel was described and illustrated, and the progress record given, in our issue of Jan. 10.

Splice Bars.—Morris, Sellers & Co., of Chicago, have manufactured a total of 9,881,236 Samson bars.

Building.—Plans for a new city hall at Saginaw, Mich., are under consideration. For particulars address R. W. Roberts, City Engineer.

Electric Welding.—The Thomson Electric Welding Co., of Boston, has orders from the Navy and War Departments for electrically welded projectiles.

New Companies.—Northwestern Engineering & Machinery Co., of St. Paul. Minn.; incorporators, C. A. Daigh, W. S. Strickland and J. M. Badger; capital stock, $250,000. National Clay Co., of Rock Island, Ill., to manufacture brick, tile and sewer pipe, etc.; incorporators, S. N. Jones, A. E. Rutledge and W. C. Butterworth; capital stock, $100,000. New Process Welding & Spinning Co., of Chicago, Ill., for welding and spinning copper, brass, etc.; incorporators, Mortimer McRoberts, Geo. D. Cook and W. L. Trowbridge; capital stock, $300,000. Northwestern Asphalt Co., of Chicago, Ill.; incorporators, Paul G. Remington, D. H. Lawton and J. R. Norton; capital stock, $300,000. Essex & Smith Mfg. Co., of Chattanooga, Tenn., to manufacture castings and machinery; president, C. W. Smith; vice-president, Henry Essex; capital stock, $30,000.

Metal Market Prices. —*Rails.*—New York: $30 to $30.75; old rails, $22.50 for iron and $18 for steel. Pittsburg: $26.50 to $27; old rails, $25 to $25.50 for iron, and $16 to $17 for steel. Chicago: $30 to $31.50; old rails, $22.50 for iron and $14 to $18.50 for steel.

Foundry Pig Iron.—New York: $14 50 to $17.50. Pittsburg: $15.50 to $16; Chicago: $14 to $15.50.

Track Materials.—New York: steel angle bars, $1.75 to $1.90; spikes, $1.95 to $2; track bolts, 2.75 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron, 1.9 cts. for steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.95 cts. for iron and 1.75 to 1.85 for steel; spikes, 2 to 2.15 cts.; track bolts, 3 to 3.1 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap welded. Casing, 50 per cent.

Lead.—New York, 4.35 to 4.40 cts. Chicago, 4 35 cts St. Louis, 4.30 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.10 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.10 to 2.25 cts.; steel plates, 2.10 to 2.30 for tank, 2.4 to 2.6 cts. for shell, 2.6 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.15 to 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.25 cts.; sheared steel bridge plates, 2.25 to 2.45 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.9 to 3 cts. universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 to 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.